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TANAKA, Tyôzaburô

A Monograph of the Satsuma Orange, with Special Reference  
to the Occurrence of New Varieties through  
Bud Variation

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# **A MONOGRAPH OF THE SATSUMA ORANGE**

**WITH SPECIAL REFERENCE**

**TO THE**

**OCCURRENCE OF NEW VARIETIES THROUGH  
BUD VARIATION**

**Tyôzaburô TANAKA**



# A MONOGRAPH OF THE SATSUMA ORANGE, WITH SPECIAL REFERENCE TO THE OCCURRENCE OF NEW VARIETIES THROUGH BUD VARIATION

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With 53 Plates.



# A MONOGRAPH OF THE SATSUMA ORANGE WITH SPECIAL REFERENCE TO THE OCCURRENCE OF NEW VARIETIES THROUGH BUD VARIATION

Tyôzaburô TANAKA

## INTRODUCTION

In the course of critical studies of Citrus fruits and their relatives conducted since 1908 in Japan and abroad, the writer's attention has been much attracted to a particular kind of orange of the so-called mandarin group, generally known by the name Unshû Mikan in Japan and Satsuma orange in America. This kind of orange seems best fitted to the general conditions of the Citrus belt of the Island Empire as well as to the Gulf Coast States of the United States, and the industry based upon this particular orange has made great development in recent years in both countries. The interests of both Japanese and American growers, properly supported by governmental institutions, made it possible for the writer to carry out a special study on all subjects relative to this orange. Some of the most important results of the investigations have been published<sup>(140)(160)(170)(172)(173)(175)\*</sup>, and the present report is a summary of the facts revealed by observation and study conducted during recent years. The writer acknowledges his indebtedness to Dr. Walter T. SWINGLE of the Office of Horticultural Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, for supervising the entire work during the past eleven years. Much assistance has been rendered also by Mr. T. Ralph ROBINSON of the same office in bringing this report to publication. The field-assistance of many persons of both countries is also gratefully acknowledged.

The Satsuma orange is produced in Japan to the value of ap-

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\* Reference is made by number to "Literature cited" given at the end.

[Mem. of the Fac. of Sci. and Agr., Taihoku Imp. Univ., Formosa, Japan. Vol. IV. May, 1932.]



proximately 18,000,000 yen (9,000,000 dollars) annually from an area of about 27,500 hectares<sup>(134)(214)\*</sup>, while the southern and the adjoining states of the United States produce an annual crop of 300 carloads of fruit worth 300,000 dollars, despite heavy losses from recent cold winters. Recently an industry based upon this orange is making rapid progress along the Black Sea coast beyond Batum\*\*, and a certain amount of the fruit is produced in Algeria<sup>(139)</sup>. In its climatic requirements, the Satsuma orange is not very exacting. It is raised easily in places where the normal mean temperature is about 60° F., and the normal annual precipitation amounts to over 1500 mm. The plant is very resistant to a freezing temperature, even as low as 12° F., when the main trunk is properly protected. The vigorous growth of the tree enables it to thrive under conditions where the summer temperature is not high enough for other oranges and the spring atmosphere is too humid. The writer recently came to the conclusion that both the Satsuma and the Washington Navel orange are the only Citrus fruits which require the least unit of heat or, in other words, they are the earliest ripening oranges of high commercial standing<sup>(161)(165)(201)(204)</sup>. They make up the largest Citrus industries of the Pacific region, beyond the northern limit of natural distribution for Citrus culture, lying along the line of 31° N. lat. Even under tropical conditions, the Satsuma behaves fairly well<sup>(153)</sup>. It is grown successfully under a great diversity of soil, from very heavy clay to mere sand, even upon soil so barren that it contains 47.5% gravel<sup>(141)</sup>. The resistance of the Satsuma to disease is also an important feature. It is resistant against mottle-leaf and many other epiphytotic diseases, like Citrus canker, gummosis, scaly bark, bark rot, melanose, and black spot\*\*\*. The plant enters

\* Value of 1928 product of Mikan, i. e., the Satsuma and a small percentage of the Kinokuni, Yatsushiro, and tangerines, is 18, 369, 520 yen. The acreage for them all is about 27, 700 hectares.

\*\* Information by Dr. N. I. VAVILOV, Director of the Institute of Plant Industry, Leningrad, U. S. S. R.

\*\*\*Based upon actual field observation in various places in Japan with the aid of Mr. H. A. LEE, former pathologist of Bureau of Plant Industry, U. S. Department of Agriculture. About Black spot fungus *Phoma citricarpa*, refer to: SOGA, Yoshihide, in *Byōchū gai Zasshi* (Journ. Pl. Prot.) vol. 7, no. 9, p. 519-526; no. 10, p. 567-571. 1920; and SOGA, Y and LEE, H. A. (translated by Tyōsaburō TANAKA) in *Nippon Engei Zasshi* (Journ. Hort. Soc. Japan) vol. 32, no. 11, p. 7-14, 1920.

into its bearing age very early and lives very long, unless it is repeatedly injured by cold. The fruits are of a larger size than the tangerines and other kinds of mandarins, with the possible exception of the King orange and Ponkan. As a commercial fruit, it has the advantage of coming into the market early in the season, thus having little competition with other oranges. It is the only fruit of high quality of the orange family which can be picked and marketed fully ripe before Thanksgiving; it is highly productive and the fruit keeps well\*. The Satsuma orange is best suited to be grafted on or budded on to the trifoliate orange (*Poncirus trifoliata* RAF.)<sup>(126)(205)</sup>, which can be raised more cheaply and more easily than other Citrus root-stocks. The Japanese shippers have demonstrated the remarkable durability of the Satsuma fruit in transporting shipments such long distances as from Shidzuoka to Seattle, or from Tsuruga to Vladivostok. It has been confirmed that the Japanese product can reach New Orleans without damage\*\*. Moreover, the resistance of the fruit juice to freezing during transportation has been repeatedly verified<sup>(75)</sup>. Recently, experiments proved that the artificial coloring of fruit by exposing it to dilute ethylene gas is not only practicable but is often necessary to bring the fruit into market at the proper time<sup>(166)(181)</sup>.

At present, the Satsuma orange industry is well established, based upon the commercial desirability of the plant itself. Yet many phases which need improvement are evident, and as our knowledge of the nature of the plant increases, so a practical improvement of the industry will result. The more there is revealed in detail as to the characteristics of the Satsuma plant, the better we will know the proper way of developing the industry based upon a sound scientific basis.

## PROSPECTUS OF THE INVESTIGATIONS

In order to carry out the investigations as to the true nature of the Satsuma orange, the work was divided into three main categories, historical

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\* The fruits are generally stored in Japan until the end of May without any refrigeration.

\*\* Based upon an information by Dr. O. F. E. WINBERG, president of Gulf Coast Citrus Exchange.

search for the origin of the Satsuma orange, taxonomic study of the plant as a species, and genetical investigations of the various varieties and strains. To solve the first question, all available references in Japanese and Chinese literature were searched, and places of importance relative to the origin of the Satsuma orange were visited. Much efficient help was rendered by Prof. Emer. M. SHIRAI of Tokyo Imperial University, under whom the study was commenced. The investigation led to the conclusion that the Satsuma orange is possibly a chance seedling from some other closely related species growing in China. Botanical literature and herbarium specimens were thoroughly examined in almost all important libraries and herbaria, and the morphological characters of the plant were carefully studied in every detail. This taxonomic study brought the conclusion that the Satsuma orange is a good horticultural species, independent of all other species, either wild or cultivated. Determinations of the specific name, descriptions of the species, and all taxonomic references were brought together. The systematic position of the Satsuma orange was also carefully outlined.

The major part of the present paper is devoted especially to the last question, the segregation of varieties and strains. Extensive field studies were carried out both in Japan and in America. Samples representing about 200,000 individual fruits were studied statistically. All representative specimens were photographed and sketched. In later years, much attention has been given to the origin of the so-called Wase characters (early maturing fruits) through independent bud mutation. More than thirty cases of such original mutations were discovered through critical examinations of all conditions of the tree and the environment<sup>(170)(172)(173)(175)</sup>. The vegetative reversion of the Wase characters to the mother form was also studied. This study has a very important economic bearing on the question of the origination of profitable varieties. All independent mutations were propagated and are under close observation in both countries. At the writer's suggestion, Shidzuoka Prefecture started an investigation on this subject, which is now under way. A special station, called Tanaka Citrus Experiment Station, Inc., has been developed in Japan principally to study the details of these economically superior varieties isolated from the mother plant. Detailed statistical figures of all varieties, together with illustrations, are given in this paper.

# BOOK I



## HISTORICAL STUDIES IN THE SATSUMA ORANGE

### THE MILK ORANGE OF WEN CHOU

Since the Satsuma orange is universally called in Japan the Unshû Mikan, Orange of Wen Chou, occasional writings<sup>(79)</sup> refer its origin to the celebrated Milk Orange of Wen Chou fu of Chekiang Province, China. The first mention of the Milk Orange of Wen Chou is made in HAN Yen-chih's "Chu lu" (A monograph of Citrus), dated Shun Hsi 5, 1178 A. D. The most reliable copy of HAN's work is found in Po ch'uan hsueh huai, compiled by Tso Kuei and printed in 1273 A. D\*. The text of "Chen kan" or genuine orange, a name given to the Milk Orange from admiration, is as follows\*\*.

"The genuine orange is the most valuable amongst the various sorts of Citrus fruits, and is to be admired. The branches, trunks, blossoms, and fruits are all different from other ordinary kinds. The tree is graceful, leaves are delicate, long, dense, deep colored, thickly covering the ground with dark shade. In the blooming time, it is particularly full of poetical purity and remoteness. The fruits are all symmetrically round, the texture of the skin is as shiny as wax. In a morning of the early frost, the gardener picks the fruit and presents it to his lord for a trial of its taste at the table. When it is opened, a fragrant mist enchants the people. This is the fruit never known to the northerners, and no one can fail to admit this is a genuine orange. It is also called the Ju kan, or Milk orange, because of its resemblance to the taste of cream. It is produced in the four districts of Wen Chou, but the product of Ni shan is admitted to be the best.

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\* The only known copy of this edition is found in the Library of the Imperial Household Department, Tokyo, Japan. Two later editions of the Ming dynasty are found in Baron IWASAKI's Seikadô Library, Tamagawa near Tokyo, Japan. These three editions have original preface, not seen by PELLIER when he wrote an introduction to HAGERTY's translation<sup>(80)</sup>.

\*\* Translation was made by the author independent of HAGERTY's, previously referred to.

This place, Ni shan, is an area not exceeding one "li" [4 km.] square. The orange produced there measures 7 "sun" [21 cm.] in girth, is thin-rinded, and the flavor is particularly good. The fibers do not adhere to the segment wall, and in eating the fruit no thread is left in the mouth. A fruit may contain only one or two seeds, but some are seedless. Orange growing on the southern slope is becoming more abundant in recent years....."

From the above given passage, the characters of the Milk Orange of Wen Chou are summarized as follows :

- (1) Different from other oranges in trunk, branch, flower, and fruit.
- (2) Regular shape of the tree and densely covered foliage.
- (3) Crowded, long, delicate leaves.
- (4) Symmetrically round fruit with waxy skin, containing an abundant quantity of oil, which is given off in a spray when fruit is peeled with the fingers.
- (5) Larger fruit measures 7 sun [21 cm.] diam., is thin-skinned, and the pulp is palatable. Fiber does not cling to the segment wall, and little is left in the mouth.
- (6) It contains few seeds, only 1 or 2 per fruit, or is seedless.

This summary will immediately show that this is not the Satsuma orange at all. The Satsuma orange does not have long, delicate, crowded leaves, and the fruit is not symmetrically round with extremely oily rind which is thin and free from the segments, etc. These characters rather resemble the Ponkan (*Citrus poonensis* HORT. ex TANAKA) or something similar, and the statement of seedlessness cannot be taken as a reliable proof that it is the seedless Satsuma, because all good semi-tropical mandarins, like Ponkan, Hairi and Kôshô Tankan, are almost seedless<sup>(13)</sup>. The orange in question is still different from that which is now abundantly grown in Wen Chou, which PELLLOT states as "Les oranges de Wentecheou sont en effet célèbres en Chire," CH'EN King-yi, the author of "Ch'uan fan pei tsu"\*<sup>†</sup>, states that it is part of HAN's error that he did not know that the same orange is grown in Huang yen of Tien t'ai,

\* The only printed copy known of this work is deposited at the Imperial Household Library, mentioned before.

not only in the Wen Chou districts. The author, however, was unable to find either the Satsuma or the Ponkan growing in Huang yen during the trip he made in 1925.\* It is, at any rate, unwarrantable to identify any sort of orange of to-day as the kind grown over 750 years ago, and moreover it would be dangerous to assume as identical plants growing in two different places, intercourse between which has been practically lacking.

There are a number of quotations about Ju kan (Milk orange) in Chinese literature, but they are mostly mere copies of HAN's writing; the descriptions remained while the fruit itself was lost from the sight of the writers. This orange became so famous in Japan, not only from the excellence of the original text, but from the admiration of Li Shih-chen\*\*, the author of the "Pen ts'ao kang mu, or standard Chinese herbal". There is, however, a diversity of opinions about the identity of the Ju kan with the orange grown in Japan. The author of "Wakan Sansai Dzu" <sup>(20)</sup> identifies it as the Japanese Kunembo (true *Citrus nobilis* LOUR.), while the authors of "Zôtei Nankai Hôfu" <sup>(22)</sup> and "Yamato Honzô" <sup>(23)</sup> make it identical with the Kishû Mikan or the Kinokuni (*Citrus kinokuni* HORT.). Recently, the Satsuma became identified with the Ju kan by MANASE <sup>(6)</sup>, ABE <sup>(7)</sup>, and TAMURA <sup>(13)</sup>, without critical studies. None of these authors made an actual search in the Chinese territories to discover the Satsuma orange growing there. These identifications are primarily based upon the description of Chu lu, and not upon any actual record of the introduction of the plant into Japan.

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\* A recent Citrus survey of Wen Chou region made by HU Ch'ang-chih also disproved the existence of the Satsuma and the Ponkan. From his report, we find three species of kumquat (*Fortunella* spp.), the trifoliate orange, a variety of shaddock, and a sour orange, a kind of Citron, the Kinokuni, and *Citrus erythrosa* with several other small mandarins, the tangerine and Kunembo, and *C. suarissina*. No other large fruiting mandarin is in existence besides the last three species in the list <sup>(4)(2)</sup>.

\*\* Pen ts'ao kang mu <sup>(5)</sup> Book 30 (fol. 27 in 1855 edition) states that "Citrus fruits are produced in Soochow, Taichou, as far west as Ching chou, and as far south as Min (Fukien province), Kuang (Kwangtung and Kwangsi provinces), and Fu (Kiangsi province), but none can be so superior as those produced in Wen Chou, which are the best." This text is unquestionably a modification of the passage found in the preface of HAN's work, which says "Oranges are also produced in Suchou, Taichou, as far west as Ching chou, and as far south as Min, Kuang and many other provinces, but they are mere Mu chu (*Citrus sinensis* OSBECK, the sweet orange) and are not comparable with the orange of Wen Chou, especially the genuine orange there produced."



There are, however, a few references in Japanese literature that give credit to the early introduction of the orange of Wen chou into Japan. According to "Satsu-gū-jitsu Chiri Sankō"<sup>(61)</sup> Book 21, p. 23, there is a place called Tachibanayama, or orange hill, in Konejime, where Shigenaga NEJIME was the ruler before the occupation of the SHIMADZU family of Kagoshima. It states that Yoshihisa SHIMADZU visited this place in 1610, and composed a poem bearing the title "At the place where Shigenaga planted the orange of Wen Chou fu, this poem is composed." The same work records that this man, Shigenaga, fought a battle with Yoshihisa SHIMADZU in 1573 against the KIMOTSUKI family. Admitting that these trees were planted at the later part of the Tenshō period\*, more than 350 years have elapsed since then. In order to see if there is any Satsuma plant growing there the writer made a trip to this spot in 1923. The orange hill, now called Mikanyama, is located on the south slope of Demejin-yama, upon which a shrine called Onimaru Jinsha is situated. The old orange grove is still in existence within the enclosure of Kesakichi KUBO's yards. The ground, about 3 tan (29.7 ares) wide, is the original location where Shigenaga planted the seeds of a Chinese orange after eating the fruit. These seedling trees are all dead except one tree, which has a single branch with an enormous spread from the trunk to the end of the branch, although the rest of the tree is practically dead. This largest sized tree is the Kinokuni mandarin. Some comparatively smaller trees of later planting are Kunembo (*Citrus nobilis* LOUR.) and Aka-mikan, or tangerine (*Citrus tangerina* HORT.). The owner of the place says that several huge trees of the latter two kinds, with trunks more than 1.5 m. in girth were lost about 20 years ago in a storm. No Satsuma tree was found there. It is, therefore, positively true that the orange mentioned by Yoshihisa SHIMADZU involves only Kinokuni, Kunembo, and tangerine, and not Satsuma. Since this place, known as Konejime, is the only port of the SHIMADZU family open to foreign intercourse, it is quite probable that many ships from China brought in the seeds of various kinds of oranges, and judging

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\* According to MAEDA<sup>(60)</sup>, the seeds were planted after Yoshihisa built a villa in 1564.

from the present knowledge of Citrus fruits grown in the Chinese coast<sup>(41)(42)(151)</sup>, the Kinokuni must have come from Wen Chou or Huang Yen in Chekiang Province, the tangerine from Foochow, Wen Chou or T'ang Ch'i (Chekiang Province), and the Kunembo from Luchu or Huang Yen.

There is another reference to the introduction of the Wen Chou orange into Japan. Under Ju kan (Milk orange) in IWASAKI's "Honzô Dzufu" (Book 62 fol. 8)<sup>(45)</sup>, it says "As to Ju kan: According to Mr. TAMURA, a Korean brought this into this country and called it Kan-su. The shape of this orange resembles the Kunembo but it is smaller. The color of the rind is more beautiful than the Kunembo. It is similar to a Mikan but is larger, very fragrant, and tastes very sweet. The peel is little in quantity and thinner than that of the Kunembo. It is, according to him, the Milk orange of China."

This orange is most unmistakably referable to the Japanese Daikôji (a relative of Tankan, *Citrus tankan* HAYATA), rarely cultivated, but is still grown in Quelpart Island under the name of Kan-su.

A new introduction of the Japanese Satsuma orange into the Wen Chou region was recently reported by Hu Ch'ang-chih in his mimeographed preliminary report of the second survey of Citrus districts of south China<sup>(46)</sup>. More than one hundred plants of the Owari variety were introduced seven or eight years ago into P'ing Yang, near Wen Chou, and were planted in the yard of the Chêng Lou primary school. They are called Jih Pên Kan, or Japanese orange, and are now producing a crop of 20 to 30 pikul (1200-1800 kg.) every year. The reporter admits that this introduction of the Satsuma plants is the first ever made, and is to give a start to the development of a new industry in southern China.

From the references given in this chapter, the Japanese Satsuma orange is definitely not of Chinese origin, as has been repeatedly pointed out by the author<sup>(17)(147)(149)(151)(152)(162)</sup>.

## THE WEN CHOU ORANGE IN JAPANESE LITERATURE

The first occurrence of the name Unshôkitsu (orange of Wen Chou) in Japanese literature is perhaps a citation in "Isei Teikin Ôrai", one

of the oldest books of family letter writing, composed by KOKWAN (1278-1346). It gives the name in the Chinese characters with the equivalent Japanese letters reading "Ujukitsu". The principal edition of "Teikin Ôrai," compiled by GEN'E, a younger brother of KOKWAN, gives a wrong Chinese character for "Un", the letter "cloud" (Yun) being substituted for the letter "warm" (Wen), and both having the same sound in Japanese. "Kagakushû", a dictionary compiled by TOROKU HATOTSU (pseudonym) written in 1444, points out the error, and gives the equivalent Japanese characters reading "Unjukitsu". "Sekiso Ôrai", another letter writing book edited by Kaneyoshi ICHJÔ (1402-1481), gives "Unshukitsu" as the pronunciation, while the wrong letter "cloud" is copied in "Shinsatsu Ôrai", by GAN'A, dated 1380, without any pronunciation being given. These references show that the name of Unshû or Wen Chou orange existed in Japan as early as the middle of the 14th century and referred to certain kinds of oranges produced there, called Ujukitsu, Unjukitsu, or Unshukitsu (not Unshûkitsu, as they were called later). The determination of the identity of these oranges is, however, impossible, due to the lack of a reliable description. It is, however, presumable that such orange or oranges must have been rather important, being mentioned together with other standard kinds, like Yûkô, Kanshi (or Kôji, *Citrus leiocarpa* HORT.), Kabuchi (or Daidai, *Citrus Aurantium* LINN.) and Kitsukan (or Kinkan, *Fortunella* spp.)

The earliest work which gives a description of the Japanese Wen Chou orange is "Yamato Honzô"<sup>(2)</sup>. In fol. 9 of Book 10 of the 1761 edition of the same work, the following passage is seen :

"The orange of Wen Chou has leaves resembling those of Mikikitsu (a kind of orange without description) but thinner and smaller : It also resembles the latter in the size of the fruit and the texture of the rind, but it has a thicker rind. The flavor is also similar, but the inner layer of the rind is thinner, and the flavor of the rind is inferior to the latter. The rind is redder. The taste of the pulp becomes far better in February and March (lunar calendar) : It is produced in the province of Tosa. This orange is called in Japan, the orange of Wen Chou. The "Pen ts'ao (kang mu)", quoting Chu

pu\*, says that the product of Wen Chou is the best. Generally speaking, things mentioned in "Pen ts'ao" sometimes agree with things found in Japan but sometimes do not. In the case of oranges, there are some found only in one place and not in another, and both bearing the same name but being entirely different"\*\*.

Apparently the author of "Yamato Honzô" suspects the identity of this Japanese orange with the Chinese kind of the same name, but he admits that the name is perhaps taken from Chu lu, quoted in the standard Herbal. Ranzan ONO<sup>(80)</sup>, in commenting on the "Yamato Honzô", says that the name of this Japanese orange must have come from Wen Chou fu, the place celebrated for the orange, but the true Chinese name of this orange is unknown. The identity of the orange mentioned in "Yamato Honzô", is questionable, but it is neither the present Satsuma orange nor the present Wen Chou orange described later. It seems most likely to be the tangerine of Tosa (*Citrus tangerina* HORT.), although the characters described do not thoroughly agree with the latter fruit. The Satsuma orange does not possess a small, thin leaf, a thin inner layer of the rind, a flavor inferior to other kinds, or the red-colored rind. The Mikkitsu, which was compared with the orange of Wen Chou, is frequently spoken of as Mikan (Honey orange) in the same work but lacks identity. In several places he mixed up the Mikan with the Tachibana, a wild species now known as *Citrus tachibana* TANAKA. The Mikkitsu may be the Kinokuni, or more presumably the true Satsuma, since the author lived in the place where the Satsuma orange surpassed other kinds in popularity.

The second work, which mentions the orange of Wen Chou, is "Wakan Sansai Dzue"<sup>(208)</sup>. Book 87, under the Chapter "Mountain fruit" sect. "Mikan" (fol. 16) states:

"The orange of Wen Chou has leaves resembling those of Yu (*Citrus junos* SIEB. apud TANAKA) and slightly smaller. The fruit

\* A synonym of Chu lu, mentioned before.

\*\* A similar text can be found in Gyûzan KATSUKI's Kwankwai Shokukan (Pocket mirror of dietetics) dated 1716 on fol. 158, which states, "The orange of Wen Chou resembles Kitsu (Kinokuni) but is thinner and smaller. It comes from Tosa, and is most delicious in February and March".

equals the Mikan in size, but has a thicker rind. The fruit is extremely acid, very aromatic, and excellent when used in seasoning fish salad. Wen Chou is located in the southern part of Chekiang, and is a place similar to Kishû in this country in producing the best oranges. It is doubtful whether the present kind was transplanted from there or not."

This particular orange, bearing the name of Wen Chou orange in Japan, is also entirely different from the present Satsuma orange. Such acid fruit, besides the Yuzu (*Citrus junos*), is seldom cultivated, except certain hybrids of Yuzu, like Sudachi, in Awa Province, or Mochiyu, in Tosa Province\*.

These two references show clearly that the orange known in Japan at least up to the end of the eighteenth century as the orange of Wen Chou was not the present Satsuma orange at all, and this fact makes it certain that if the Satsuma was present at this period, it must have been called by an entirely different name.

## EARLY EXISTENCE OF THE SATSUMA ORANGE IN JAPAN

According to the survey of TAMURA<sup>(17)</sup> and ABE<sup>(2)</sup>, the following synonyms of the Satsuma orange are available :

- (1) Rifujin (2) Nakashima Mikan (3) Ujukitsu (4) Tachibana  
 (5) Yatsushiro (6) Yukô (7) Ômikan (8) Tômikan (9) Tanenashi  
 Mikan (10) Hadayoshi (11) Kairyô Nezaki Mikan (12) Bishûkan  
 (13) Senshû Mikan (14) Usukawa Kunembo

The writer's study shows that the first name is the most popular among others commonly used in Shikoku Island (four provinces), Settsu Province, Idzumi Province, and Kii Province. The next popular name is Tômikan, used in the provinces of Suruga, Tôtômi, and Hizen. Both names are related to China. The first means "the orange of Queen Li" and the second "the orange of T'ang (China)". These names are

\* The Yuzu and its hybrid do not occur in Wen Chou, according to the reports of HU<sup>(41)(42)</sup>, and no acid fruit other than a kind of sour orange is known from this region.

frequently cited in early Japanese works. The author of "Yamato Honzô"<sup>(52)</sup>, again states that there is an orange called Tômikan in the western provinces which has a remarkably thick rind and the size of the fruit is similar to Yuzu. It says "the rind is reddish and the taste is good. It contains very few seeds, and often no seed is found in the fruit." This is almost referable to the Satsuma orange.

Still later on, IWASAKI<sup>(45)</sup> describes the Tômikan as follows :

"A kind of red-skin orange, called Tômikan. Produced from the provinces of Chikuzen and Chikugo. It is said to be of Chinese origin. The fruit is larger than Kan (Kinokuni) and the texture of the peel is fine and smooth, like that of the Kunembo. The rind is red and the taste of pulp is sweet. It contains few seeds."

This is still closer to the present Satsuma orange, and the same thing occurs in the work under "the orange of Tung Ting" as follows :

"The orange of Tung Ting, or Ryôjin Tachibana\* is generally planted now-a-days, after its first introduction from Korea by the Lord of Yanagawa (of Chikugo Province). The fruit resembles Jagatara (orange of Batavia, presumably a shaddock) but is slightly flatter, and it has a skin which is much finer and thinner. The taste of the pulp is good and it contains few seeds."

The illustration indicates a comparatively large sized fruit of orange color, with a rather large sized calyx. The lamina of the leaf is large and is articulated to a considerably large-sized, yet rather obscurely outlined, petiole wing. Except the exaggeration of the alated petiole, all the characters agree with the Satsuma orange. The orange of the same name, later referred to by Count Kwanji TACHIBANA, a descendant of the Lord of Yanagawa, is unquestionably the Satsuma orange, according to his own work<sup>(12)</sup> and the description given by SUZUKI<sup>(123)</sup>.

The scabby Satsuma orange is also mentioned in IWASAKI'S work under the name "Lion head orange". It says: "Lion head orange or Unshô Tachibana, is much cultivated in Suruga Province; the fruit is

large and like Yuzu and a little flatter; when mature it becomes reddish-yellow and has green warts which make it look like the back of a toad. It tastes sweet." The picture of the Lion head orange also shows the leaf with large petiole wings. This winged character seems to be merely an inaccurate presentation from a wrong impression, because the text definitely says, "These three (Tung Ting kan, red skin orange, and Lion head orange) have large leaves resembling those of the sour orange but having no winged leaflet at the bottom." These three, from their characters and names still in use, are almost unquestionably the Satsuma of the present day. Toshiyasu MAEDA<sup>(61)</sup>, in his "Shûchin-kagami Honzô Kômoku", written during the Ansei period (1854-1860) gives the name "Lion head orange=Unshû Tachibana", agreeing with the above statement.

The first and most definite application of the name Unshû (orange of Wen Chou) to the present Satsuma orange is perhaps made by Shôken OKAMURA<sup>(80)</sup> in about 1828. His work, "Keien Kippu", is an extensive monograph on *Citrus*, never printed, containing very good drawings of the branch, leaf, flower, and fruit of the Satsuma. This work was perhaps written during the author's residence in Yedo (Tokyo), but came into circulation among book lovers after Chôjo TAZAWA wrote the preface in 1848 and recommended the book to the public. Unquestionably, this is a contemporary work of IWASAKI's "Honzô Dzufu", but there is some diversity of opinion with regard to the identity of some of the kinds, but opinions are fairly well agreed in the case of the Satsuma. OKAMURA's text on Unshû is as follows:

"Unshû-kitsu is vulgarly called Sanenashi Mikan (seedless orange). Its shape very much resembles a Mikan (Kinokuni) but the color is yellow and the size equals that of the Kunembo. The apex of the fruit is slightly flat, and the shape becomes not fully round under certain soil conditions, and the fruit shows ribs on the side so that one can count the number of segments from the outside. Some are conspicuously furrowed, and according to "Yamato Honzô" some attain the size of a Mikan and are redder in color. The leaves are like those of the Kitsu (Tachibana) but are large and long, though in different

places they are smaller. The texture of the rind is similar to the Mikan, but it is more coarse. The peel is softer than that of all other kinds of oranges and tastes milder, with little bitterness. The pulp is mild in taste and sweet, and it contains no seed. Rarely one finds one or two seeds, but the seeds, when they are found, are always round, quite different from the pointed seeds of the Mikan. As to its name, Unshû (Wen Chou) is unquestionably the name of the place where excellent oranges are produced, therefore twenty seven kinds are mentioned in Chu lu, none of them being similar to the present Unshû-kitsu. Although it is called "Kitsu" (small mandarin), it is a member of the milk orange group (large mandarin) and is not a kind of Tachibana. There is, however, a plant called Tachibana (or Kitsu) in Yanagawa, and this is similar to the Unshû-kitsu. According to the tradition, the seed of this kind was brought back at the time of the Korean expedition of TOYOTOMI Taikô, but whether this is true or not, I do not know. It is, nevertheless, thriving here and there and bearing fruits as large as those of the Kunembo and the flavor excels the Mikan. Local inhabitants call it the Orange of Queen Li (Rifujin-kitsu). There are two plants in the garden of Masayoshi MOTUYAMA, the height of which is 1 jô [3.03 m.] and it bears no thorns. The leaves are about 4 sun [12.1 cm.] long and 1.5 sun [4.5 cm.] broad, resembling very much those of the Mikan but with a coarse crenation on the margin. Each tree bears about 300 fruits every year....."

The drawing shows the definite characters of the Satsuma, such as the elongate, cylindrical flower bud, large calyx, wide expanding linear petals, tubular stamens much shorter than the style, etc.

Another more complete monograph of Citrus fruits bearing a later date, is Keishi MURASE's "Nankai Hôfu\*", of which only a manuscript of the revised work by Shinko YAMANAKA is in circulation. It mentions Sanenashi Mikan but this is the seedless Kinokuni, and not the Satsuma. The Tômikan, given in this work, is also different, because it has a

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\* About the bibliographical reference of this work, see TANAKA, Tyôzaburô in Fla. State Plant Bd. Quart. Bull., 3: 1-15, 1918, and in Phytopathology 13: 492-495, 1923.



rough yellow skin and a bitter segment wall. The Lion head orange, mentioned in this work, is a scabby Kunembo, and also not the Satsuma. The Milk orange, bearing the names Unshû-kitsu (both Wen Chou and Yun Chou oranges) is described as follows :

“Synonym: Mifue Mikan (Abundant fruiting orange). Kin-kunembo. The shape and color resembles the Kunembo. It has a rind which is smooth, thick, and reddish-yellow. The pulp tastes sweet and is palatable, and the fruit juicy. It contains few seeds. The shape of the tree and the leaf resembles the Kunembo and the Yatsushiro.”

This is unquestionably the Satsuma, and the illustration also agrees. “Kin-kunembo”, given as a synonym, is still in use in the same locality (Arita valley in Wakayama prefecture) in an abbreviated form “Kin-kyû”<sup>(7)</sup>.

The orange of Queen Li is also mentioned, but its description is very meager. The text is by YAMANAKA and not by the original author. In the original work of MURASE, the Tômikan and the Lifujin-kitsu are both definitely the Satsuma. OHARA<sup>(8)</sup>, in the table of contents of the original work gives: “Tômikan; synonym—Kôrai-kitsu (Korean orange), produced in Owashi-ura of Kumano. Chinese name unidentified. “Kuo su” (Comment of fruit) by WANG Shih-fan gives a kind of vermilion orange, Chu chû, with red skin and large outline, which probably is it,” He further goes on: “Li Fujin Kitsu. syn. Unshû Mikan (Yun Chou orange), produced at Yuasa of this province. Also Mifue-mikan of the same place, and Kin-kunembo: These are recent names: Chinese name is unknown.”

These references bring us to the conclusion that the Satsuma orange was known in books under the various names of Tômikan, Rifujin-kitsu (Li Fujin Kitsu) and by some other local or incidental names, and that later the name Unshû was adopted definitely as the standard name of this orange. Therefore, the present use of the name Unshû Mikan as the standard Japanese name of the Satsuma orange has been current only about one hundred years.

\* See NITAWAKI in *Nippon Engei Zasshi* (Journ. Hort. Soc. Japan) vol. 27, no. 5. p. 4. 1915.

## THE EXISTENCE OF OLD SATSUMA TREES IN JAPAN

If one admits that the author of "Yamato Honzô" knew the Satsuma orange, the early existence of it dates back about two hundred and twenty years, according to written sources. If this is true we should find old trees corroborating this information. There are a considerable number of old trees in existence in Fukuoka Prefecture, especially in Tokudani, in Yame county<sup>(83)</sup>. Old trees are also abundant in Minô, Fukutomi, and Morihe in Ukiha county in the same prefecture. The unusual abundance of such old trees in Fukuoka Prefecture means their early introduction into actual cultivation. Leaving out any reference to the record of Korean origin, mentioned before, we know the Lord of Kurume, Count ARIMA, did much planting of the Satsuma as also did the Lord of Yanagawa. In Fukuoka Prefecture the Satsuma is simply called "Mikan", which name refers to the Kishû Mikan (Kinokuni) in other prefectures. SUGIYAMA<sup>(124)</sup> states that "Mikan" trees were planted in the castle of Kurume, and the place is called "Mikan no Maru" or the Courtyard of Citrus. The fruits were then carried to Yedo as it was customary to make a gift to the Shogun. This shows that the cultivation of the Satsuma was just started in the middle of the eighteenth century. A writing of KABASHIMA<sup>(48)</sup>, and the private record of the Lord\* also makes reference to the customary presentation of Satsuma fruit to the Yedo dictator. TODA<sup>(112)</sup> makes a reference to the growing of the Satsuma and other oranges in the counties of Ikuha, Takeno, Yamamoto and Mii in the early part of the Meiji era (about 1865). The largest tree which survived until lately was found in a garden of Hatsujirô KOGA, planted about 1786, and ABE<sup>(2)</sup> measured the girth of the trunk which was 2.07 m. at the bottom; the whole tree had a spread of about 7.8 m. The same tree was 5.2 m. high, 8.7 m. in diameter, and had a girth of 2.03 m. at the bottom of the trunk, according to a study of the Prefectural Agricultural Department in 1911. Mr. Uichirô SAEKI, formerly County Agent, measured the same tree in 1916, and gave the results to the writer. He gives the height as 6.8 m. the spread of the

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\* Courtesy of Count Yoriyasu ARIMA.

branches East to West, 9.3 m., that of North to South 8.7 m. and the diameter of the three main trunks at the height of 3.3 cm. from the ground, 56 cm., 63 cm., and 78 cm., respectively. This tree suffered severe injury by cold in 1917, and was in a very poor condition in December 1918, when Dr. W. T. SWINGLE and the writer examined it. It died in the spring of 1919. According to Mr. SAEKI, there was another large tree that died in the same year, which measured 5.2 m. in height 7.8 x 9.6 m. in the spread of the branches, and 1.5 m. in the girth of the trunk. These trees had lived some 150 years from their planting.

The largest Satsuma tree ever found is perhaps the huge tree located in the garden of Toyoji KAWANO, at Kusugase, Fukutomi, Aoe-mura, in Ôita Prefecture. In 1920, the writer measured the tree, and found the height was 7.3 m., the E.-W. spread of the branches 10.6 m., that of N.-S. 13.9 m., three main trunks measured 96 cm., 73 cm., 93 cm., in girth, respectively. It was estimated that it had lived about 200 years at that time, and was about 50 years older than the trees in Fukuoka Prefecture. The milder winter of Ôita Prefecture perhaps accounts for its longer life, because there is a huge Kinokuni tree still standing, which has a definite record of more than 400 years. The Satsuma is called, in this prefecture, the "Yatsushiro", because the Lord of Yatsushiro of Higo Province (a little south of Kurume) brought it to this place\*.

This proves that the Satsuma orange tree dates back at least two hundred years as shown by living trees, but it is believable that the actual beginnings of cultivation were still earlier than the record shown by these trees, which have come incidentally to our observation.

### THE ORIGIN OF THE CULTIATION OF THE SATSUMA ORANGE

The value of Count TACHIBANA's reference to the Korean origin of the Satsuma orange is rather doubtful, since Korea, except Quelpart, is

\* OSHIKAWA, Jōsui, in Kwaju (Fruit tree) No. 158 p. 11, 1916, writes that the origin of this local name is taken from the feudality of Lord HOSOKAWA of Yatsushiro, who gave the Satsuma trees to the villagers in thanks for their faithful service in the role of sailors when he made his way to Yedo en route through Tsukumi, near Aoe village.

too cold for any kind of orange to grow. This is perhaps based upon a short note given in "Honzo Dzufu", but a still longer account is given in "Keien Kippu"<sup>(89)</sup>. It states that the Unshû-kitsu was brought into Yanagawa, Chikugo Province, now in Fukuoka Prefecture, during the Taikô expedition to Korea (1592-1597). Further it records:

"In 'Tong eui po kam',\* four kinds of Citrus and Citrus products are mentioned: Chu-pi (orange peel), Ch'ing pi (green Citrus peel), Yu-tsu, and Ju-kan (Milk orange). Under the chapter on Chu-pi, it says that within our territory only Quelpart produces these products, green Citrus peel, Yu-tsu, and Milk orange. It, however, does not mention Unshû-kitsu, but if the product of Yanagawa has its origin in Korea, it must be the Milk orange mentioned in this 'Po kam'."

His identification of the Satsuma orange with HAN Yen-chih's Milk orange is perhaps based upon this quotation, and MANASE<sup>(65)</sup> expresses the same opinion—that the Satsuma, identical to the Milk orange of Chu lu, came through Quelpart. No critical examination of the orange of Quelpart had ever been made until the author took up the matter.\*\* There exist twelve kinds of Citrus at present, none of them corresponding to the Satsuma. Father FAURIE's extensive collection of Quelpart plants also does not include the Satsuma. A manuscript work, called "Tanra Jijitsu," written by a Korean\*\*\*, gives 16 kinds of Citrus fruits grown there, and it includes the milk orange in question. It states:

"Ju kan (Milk orange). Size as large as early red kaki persimmons. Rind thin and color green; contains few seeds. Flavor sweet, refreshing, acid, and fragrant."

It seems quite doubtful that this corresponds to the Satsuma. No texts with reference to other kinds of *Citrus* mentioned in this work correspond to the Satsuma. There is another proof that the Satsuma did not exist in the island, because the inhabitants just recently became

\* A Korean medical cyclopedia written by HŬ Tjyoun in 23 books, published in 1562.

\*\* A considerable amount of herbarium specimens of *Citrus* was collected by Father FAURIE and his collaborators in Quelpart. These specimens were distributed to many herbaria in Europe, but none of them were ever studied critically. The author recently examined these specimens in Edinburgh, Kew, Zürich, Paris, etc.

\*\*\*The author is indebted to Prof. T. NAKAI for sending him the text of this work copied from the manuscript.

acquainted with the Satsuma and have now started planting the Satsuma on a very large scale. An enormous number of nursery plants of the Satsuma have been introduced in the past several years from Fukuoka Prefecture. There is, therefore, no justification for the belief that the Satsuma originally came from Quelpart. Geographically the island of Quelpart is nearest to T'ang chih near Hangchou, Wen Chou, and Huang yen, among the Citrus growing districts in China. Some of the Citrus growing in the island is common with that in these districts. There is no wonder that the Satsuma is not found in Quelpart, as long as it is absent in the latter places.

In hunting through the Japanese literature, the author ran across Ittsûshi Gensen KANDA's "Honzo Wakumon",\* which gives an account of the Satsuma. The text reads as follows:

"Yu. Japanese name Tômikan : Japanese name Higo-mikan : Japanese name Ônakashima. The origin of this plant is in China, first planted in Ônakashima in Higo province, hence its name."

It gives a sketch of a round fruit together with a few large leaves, with the names Tômikan, Higo-mikan, and Ônakashima again in Japanese letters. This is unquestionably the Satsuma, because, not only the drawing agrees with it fairly well, but all these names are referable to it. Tômikan, which is one of the common names of the Satsuma, as stated before, is here definitely explained as due to the Chinese origin. Higo orange is from the locality where it was first planted, and as was stated before, Higo is the native home of that huge Satsuma plant the writer found in Ôita Prefecture. There is, however, no place now called Ônakashima or Nakashima in Higo province. The only reference obtainable through YOSHIDA's Japanese geographical cyclopedia, is the island of Nagashima of the Amakusa archipelago, which was formerly called Nakashima. This island had belonged to the Lord of Higo, of the SATAKE family, before he was conquered by the SHIMADZU family of Satsuma Province, and was made a district of the same province, as it remains now. This island Nagashima has a very good port, called Kuranomoto, where occasional boats from China have anchored<sup>(51)</sup>. Communi-

\* Thanks are due to Prof. M. SHIRAI for calling the author's attention to this work.

cation from this island to the Chinese port is known as the noted account in the Supplement Record of the Empire\* records the route of a boat returning from China in 777 A. D. NAKAMURA<sup>(78)</sup> states that it is certain that the old name of the island is Nakashima, according to the citation in the Supplement Record, and it belonged to Amakusa county of Higo Province. The same author says "In Higashi Nakashima-mura, Citrus fruits are abundantly produced in Yamatono and Kawatoko", and "In Higashi Nagashima-mura, Citrus fruits are much produced in Shimo Yamato, and are called 'Shima Mikan' (orange of the island), which are harvested during the fall and shipped to Higo and Hizen provinces. These oranges are one of the noted products of the island."

Since the work of KANDA was written about Genbun 3 (1737), it is evident that the Tômikan was also called Ônakashima about two hundred years ago. The Satsuma is now exclusively called Nakashima or Ônakashima in Nagasaki and Saga prefectures, and this name is undoubtedly referable to the Tômikan of KANDA's work. The island may then have been called both Nakashima or Nagashima. The writer<sup>(18)</sup> pointed out that SIEBOLD, during his stay in Nagasaki about 100 years ago, collected a specimen of the Satsuma grown there and placed with it a label in his own handwriting, using the spelling "nagasima", not Nakasima. This was later mis-spelled as "nagasimo" by MIQUEL<sup>(73)</sup>, FRANCHET and SAVATIER<sup>(82)</sup>, and others, and they also cite "Nakasimahacan", unquestionably for Nakasima mican. These instances show that both ways of spelling, Nakashima and Nagashima, are correct, as is the case for the spelling of the name of the island. This name clearly shows that the Satsuma grown in the Nagasaki region must have come from that island, and must have an old record of cultivation. The writer, after search in the Ikiriki region in Nagasaki Prefecture, learned in 1920, that a huge tree of the Satsuma orange with a spread of about 9.6 m. existed until 87 years ago. This tree belonged to a man called Mansuke MOTOMURA, and the second generation tree from this plant existed about 30 years before this time, once bearing 5000 fruits at its full maturity when 50 years of age. The first huge tree must have survived at least 200

\* Shoku Nihongi. Kokushi Taikêi edition M. 30 (1897) p. 617-620.

years, judging from its enormous size. Therefore, the early cultivation of the Satsuma in this place must go back about 300 years from the present time. This gives sufficient support to the belief that the cultivation in Nagasaki Prefecture is older than in other places, and that the plant called Nakashima is from the island of its original introduction from China, according to the 200-year old statement of KANDA, mentioned above. The writer has not visited the island, but information received through the Prefectural horticulturist states that there is no large Satsuma tree living there now. It seems probable, however, that the Satsuma was disseminated in three directions from the island—northwest to Nagasaki, north to Chikuzen and Chikugo (Fukuoka Prefecture), and east to Higo (Kumamoto Prefecture). Across the island of Kyushu it traveled from Higo to Bungo (Ôita Prefecture), where old trees were found. It further traveled from Bungo to Iyo by crossing the Bungo Channel, and there we see old Satsuma trees also in Tachima village, thriving at about 200 years of age. In Tosa (Kôchi Prefecture) on the same island, trees of similar size were recorded<sup>(137)</sup>. No large Satsuma trees have ever existed in any other places in Japan. The evidence brought to light now brings us to the conclusion that the record of KANDA agrees fairly well as to the distribution of old Satsuma trees, if Nagashima is taken as the first foothold of the Satsuma orange in Japan.

### NATIVE HOME OF THE SATSUMA ORANGE

The question then arises from what part of China the Satsuma orange originally came. To solve this question, the author made a survey through the coastal region of China in 1923 and 1926. The Citrus areas visited were in the vicinity of Canton in Kwangtung Province, Ch'au chou, near Swatow, in the same province, Chang chou, near Amoy, in Fukien Province, Foochow, in the same province, and Huangyen, in Chekiang Province<sup>(138)</sup>. No Satsuma orange was found in these localities. From historical evidence, only the last two places were accessible to the early Japanese envoys to China, and these places have only hardy species and varieties of *Citrus*. Only the true tangerine (*Citrus tangerina* HORT.) is

extensively grown in Foochow, and among the Japanese envoys who went to Foochow, such a celebrated monk as Kūkai definitely stated that he brought back the seed from there\*. The tangerine is only grown to a certain extent in the provinces of Satsuma and Tosa, and it did not become a favorite orange because of its inferior quality due to the lack of sufficient summer heat. It grows in a very small quantity at T'ang chih and Wen chou in Chekiang Province. These places are more like the western coast of Kyushu Island in temperature relations, but direct intercourse with the Japanese port was not so active in the old days as with Huangyen of the same province. Many monks of the Tendai sect must have passed the mouth of the branch river leading to Huangyen, on the way back and forth to visit the principal temple of the sect located on the mountain of Tient'aishan, about 72 km. from there. We find in Huangyen an extensive cultivation of the true Kinokuni (*Citrus kinokuni* HORT.), which was the favorite Citrus fruit in Japan before the Satsuma came into commercial use. Only in this one place along the Chinese coast we find a spicy mandarin, called the Jimikan in Japan (*Citrus succosa* HORT.); it has a very long history of cultivation and still forms one-fifth of the total Citrus production<sup>(151)</sup>. A small vermilion orange, the Kobeni-mikan of Japan (*Citrus erythrosa* HORT.), is also very common, but this and the Kinokuni are distributed in the northern Citrus regions<sup>(41)</sup>. It is most probable, however, that these oranges were brought to Kyushu from Huangyen by these early envoys, and they must have come true to seed. The Satsuma does not exist in these places, but its closest relatives exist in Huangyen, which has the richest Citrus flora along the Chinese coast<sup>(151)</sup>. First, it has the Jimikan, mentioned above; second, the Man kieh (*Citrus tardiferax* HORT.) never known to the Japanese, and third, the Ts'ao kieh (*Citrus subcompressa* HORT.) and its seedless form, new to the horticulturist. The author has already advanced the opinion<sup>(122)(157)(158)</sup> that the Satsuma orange is possibly a chance seedling of these close relatives. This point will be discussed later.

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\* Information by Prof. M. SHIRAI obtained from Kakai's work Shôrai Mokuroku.  
(probably a mistake for "Shôryôshû".)



As stated before, the island of Nagashima is very famous for the production of the "Shima Mikan" which is nothing but the Kinokuni. The oldest known Kinokuni tree is still in existence in Kôda-mura, in Higo Province just opposite the island\*. This tree has a record of 600 years of existence, and the nearest source for the importation of this tree is only Nagashima Island. That the Kinokuni of the island came from Huangyen is the only possibility, because there is almost no other way of explaining its importation from abroad<sup>(151)</sup>. The Kinokuni was also found by the writer to be produced in Nanfeng in Kiangsi Province, China, but the place is too far interior to have made any shipment from it possible, especially at such an early period. It grows in other places in Chekiang Province, as stated before, and may grow along the River Yang-tze, but direct importation from these places is unthinkable. Admitting that the Kinokuni was imported from Huangyen through seed, why should other kinds have not been similarly introduced\*\*? The Japanese learned monks, such as Kôkai himself, were all very active in plant introduction\*\*\*, and these Tendai priests, as pilgrims to Tient'aishan, must have tasted Huangyen oranges, which are generally called Tient'aishan oranges, and brought back the seeds of the Kinokuni, the Jimikan, and other Satsuma relatives, from which the Satsuma came up as a mutant. Such instances of a chance seedling bringing forth a new species are discussed later.

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\* See an excellent photograph as frontis piece of IKURÔ TAKAHASHI'S *Kankitsu Saibai* (Citrus culture) Tokyo, Seibidô, 1913. He states that plant used to have a spread of 35m.

\*\* It is interesting to note that Prof. HU<sup>(2)</sup> found the Jimikan only in Huangyen, not in any other place on the Chekiang coast. It is very widely distributed in Japan, and even reaches Quelpart under the name Wa-kits, meaning the Japanese orange. Jimikan is the name given in Tosa province, and it is called various names such as Shôji Mikan, Shikinari Mikan, Maru Mikan, and Kôda Mikan. The last name is based upon Kôda-mura, where a 600 years old Kinokuni tree is found. No study was made whether it does occur on Nagashima Island or not, but Kôda is the opposite to the island, as stated before.

\*\*\* *Dolichos lablab* is called Ingen-mame (Ingen bean) in Japan, because it was introduced by the noted monk INGEN from China. Many other kinds of plants were introduced into Japan by Buddhist monks.

## HISTORY OF ECONOMIC CULTIVATION OF THE SATSUMA IN JAPAN

Although the Satsuma has been cultivated three hundred years in western Japan, its general recognition as the most profitable kind in Japan came very slowly. In the early days before Meiji (1868), the Kinokuni was the only economic kind of Citrus fruit, and this was the condition until about 1875. In Wakayama Prefecture, where the largest amount of Citrus fruits are produced, the commercial shipment of Kinokuni to Yedo (Tokyo) began from 1634, and in the next year the amount was about 2,000 baskets. The shipment increased to 350,000 baskets in 1712\*. In the year 1878 this prefecture produced 1,039,826 boxes of Kinokuni, worth 306,748 yen\*\*, and the amount decreased to 1,449,269 kwan (5,434,759 kg., about 78,328 boxes) valued at 304,906 yen, in 1917\*\*\*. This decrease was due to the introduction of the Satsuma into extensive cultivation. The Satsuma was first known in this producing center in 1810, but no importance was attached to this orange until about 1882. In 1917, the Satsuma was produced in the same prefecture to the amount of 1,210,949 kwan, (4,541,059 kg.) valued at 783,429 yen, about twice as high as the Kinokuni.

In Idzumi Province, Ôsaka Prefecture, which lies north of Wakayama, the Satsuma remained unknown until the Tempô period (1830-1844), and it suddenly came into popularity about 1887\*\*\*\*. ABE<sup>(2)</sup> states that Shirokane of the same prefecture experienced the first activity of Satsuma "boom" in about 1882, while other growing centers like Kayafu reached this stage about 1887. These two principal Satsuma districts, Wakayama and Ôsaka, owe their activity to the Ikeda nursery center, where the Satsuma had been known for about 170 years. Very few

\* See TANAKA, Tyôzaburô. *Nippon Kankitsugyô no Kwako*, Genzai oyobi Shôrai (On the past, present, and future of the Japanese Citrus industry) in *Kankitsu Kenkyû* (Studia Citrologica) vol. 1, no. 1. p. 80-84. S. 2. 1927.

\*\* See FOUKOURA, Y. *Kishû Kankitsuroku* (Record of Citrus culture in Kii Province) Wakayama, 1881, p. 2, 20-38.

\*\*\*See *Mikan no Kishû* (Orange province Kii) published by Wakayama-ken Agricultural Society. 1919 p. 102.

\*\*\*\*See *Nôji Chôsa* (Agricultural report): Ôsaka Prefecture, compiled by Department of Agriculture and Commerce vol. 3. f. 12. 1890.

groves of the Satsuma are found in the latter district, but the cultivation started on the hillside in Minoo about this date still remains active, and supplies budsticks to the nurseries.

In the central part of Japan, Nezaki in Mikawa Province, Aichi Prefecture, seems to be the first place where the Satsuma was planted about 170 years ago, although active cultivation started about 1880. This place supplied the Owari nursery center with planting materials, to which the present development of the Satsuma districts in Shidzuoka, Kanagawa, and Aichi is principally indebted. In Shidzuoka, Okabe in Suruga Province first started the economic cultivation of the Satsuma about 1873. In Kanagawa, the Satsuma has been known since between 130 and 140 years at Kawamura, and about 100 years at Maegawa, but activity in planting started very late, perhaps after 1890. In Aichi, like Yamazaki in Mino Province, economic planting began as early as about 1879.

In Hanada, Mikawa Province, Aichi Prefecture, this period came about 1881. In Fukuchi of the same province, economic propagation of the Satsuma is said to have started 90 years ago, but its active stage came only in about 1880. In Kyushu Island, Nagasaki developed its own industry from plants propagated locally from an old plantation, but in Fukuoka the nursery industry of the Satsuma was developed in the Tanushimaru district from its old plantations in about 1887. The large production of Fukuoka and Kumamoto is chiefly due to this nursery district, but the southern prefectures remained undeveloped until very recently.

In Shikoku Island, Tachima in Ehime Prefecture developed its Satsuma industry from about 1873, but its later development is chiefly due to local propagation. Other prefectures did not join in the advancement of Satsuma culture.

The following table will give some idea about the present production, together with the approximate date of first planting and first economic cultivation.

## STATISTICS OF SATSUMA PRODUCTION IN JAPAN

Since the statistics of the Department of Agriculture and Forestry give only the amount of production of loose skin oranges, including the Satsuma, the Kinokuni, the Kunembo, the Yatsushiro etc., it is impossible to know the exact production of the Satsuma only unless a special tabulation is made. From the middle of August, 1930, the data for the Satsuma production was sought by requesting that the statistical figures of each prefecture be sent to Taihoku. At the end of July, 1931, the figures were almost complete, and the tabulation was worked out by Mr. Y. TANAKA, and is abstracted below :

### SATSUMA PRODUCTION IN 1929

Prefecture	No. of trees	Production in <i>Kilo</i>	Value in <i>yen</i>	Percent to total Citrus production
Miyagi	0	0	0	0
Fukushima	0	0	0	0
Ibaraki	16,618	154,421	15,415	34.44 ( 1 )
Tochigi	466	2,760	314	5.75
Gumma	5,620	36,941	4,522	36.73
Saitama	9,202	73,271	6,811	32.92 ( 2 )
Chiba	24,399	1,273,516	116,401	48.04 ( 3 )
Tokyo	1,050	3,379	581	6.99 ( 4 )
Kanagawa	761,087	13,323,198	981,120	92.28 ( 5 )
Niigata	840	2,861	449	7.30 ( 6 )
Toyama	80	314	43	0.72 ( 7 )
Ishikawa	0	0	0	0
Fukui	38,212	201,484	25,769	53.82 ( 8 )
Yamanashi	621	5,883	464	19.83
Gifu	133,096	1,181,925	90,291	96.84 ( 9 )
Shizuoka	2,854,732	56,119,706	3,635,063	74.73 (10)
Aichi	438,379	4,530,443	388,510	82.63 (11)
Mie	297,565	2,537,809	237,408	40.53 (12)
Shiga	8,796	36,746	4,045	16.64

Prefecture	No. of trees	Production in <i>Kilo</i>	Value in <i>yen</i>	Percent to total Citrus production
Kyôto	83,880	542,618	43,868	54.33 (13)
Nara	210,242	1,346,093	124,410	55.50 (14)
Wakayama	4,270,314	43,875,345	3,185,622	53.68 (15)
Ôsaka	1,940,537	14,636,426	1,160,264	89.33 (16)
Hyôgo	82,237	732,795	64,213	22.16 (17)
Tottori	40,046	298,991	35,559	51.06 (18)
Shimane	88,059	823,313	85,439	42.26 (19)
Okayama	55,439	570,248	54,546	44.06 (20)
Hiroshima	1,151,635	9,507,300	939,736	57.87 (21)
Yamaguchi	392,018	3,679,913	333,107	17.56 (22)
Tokushima	274,505	3,821,179	235,893	38.50 (23)
Kagawa	350,014	2,722,429	256,702	54.90 (24)
Ehime	1,349,792	14,775,428	1,310,269	46.96 (25)
Kôchi	103,227	878,543	83,304	34.20 (26)
Fukuoka	610,874	3,863,539	404,182	44.77 (27)
Saga	269,201	2,877,120	265,786	65.19 (28)
Nagasaki	390,765	3,020,115	359,130	55.23 (29)
Kumamoto	412,395	3,734,786	427,101	51.76 (30)
Ôita	833,285	11,405,730	1,067,190	72.93 (31)
Miyazaki	320,311	2,962,537	265,808	64.12 (32)
Kagoshima	492,385	4,383,823	459,503	33.37 (33)
Okinawa	17	124	17	.01 (34)
TOTAL	18,312,601	209,887,557	16,718,855	58.01

*Producing localities*

- (1) Awa-mura & Takada-mura in Inashiki-gun; Sonobe-mura in Niiharu-gun; and Tsukuba-chô in Tsukuba-gun.
- (2) Shiratori-mura in Chichibu-gun; Higashikodama-mura in Kodama-gun; and Yorii-mura in Ôsato-gun.
- (3) Awa-gun, Isumi-gun, Kimitsu-gun, Chôsei-gun & Sanbu-gun.
- (4) Idzu archipelago.
- (5) Ashigarashimo-gun, Ashigarakami-gun, Naka-gun, Miura-gun.
- (6) Sado-gun, Nishikambara-gun, Nishikubiki-gun.
- (7) (scattered).

- (8) Higashiura-mura in Tsuruga-gun; Uchiura-mura in Ôi-gun; Kumohama-mura in Onibu-gun; and Uzura-mura in Sakai-gun.
- (9) Ishitsu-mura & Shiroyama-mura in Kaitsu-gun; Tado-mura & Yôrô-mura in Yôrô-gun.
- (10) Iwara-gun, Shida-gun, Tagata-gun, Abe-gun, & Inasa-gun.
- (11) Chita-gun, Hoi-gun, Atsumi-gun, Aomi-gun, & Hadzu-gun.
- (12) Sana-mura in Take-gun; Tado-mura & Fukaya-mura in Kuwana-gun; Kawarada-mura in Mie-gun; Gokasho-mura & Kanbara-mura in Watarai-gun; Adawa-mura & Ichiki-mura in Minamimuro-gun; Kuki-mura in Kitamuro-gun; Kuroda-mura in Kawage-gun.
- (13) Sagara-gun & Yosa-gun.
- (14) Shiroke-mura & Yoshino-chô in Yoshino-gun; Asawa-mura in Yamabe-gun,
- (15) Arita-gun, Kaiô-gun, Naka-gun, Ito-gun.
- (16) Senhoku-gun, Sennan-gun, & Minamikawachi-gun.
- (17) Akô-chô & Shioya-mura in Akô-gun; Kawanishi-chô in Kawabe-gun; Ryôgen-mura in Muko-gun; & Nada-mura in Mihara-gun.
- (18) Tôhaku-gun, & Seihaku-gun.
- (19) Shimada-mura & Iinashi-mura in Nogi-gun; Takatsu-chô in Mino-gun; and Yôkan-mura in Hiikawa-gun.
- (20) Hachihama-mura, Yamada-mura & Honjô-mura in Kojima-gun; and Ôshima-mura & Tsurushima-mura in Asakuchi-gun.
- (21) Ôchô-mura & Hisatomo-mura in Toyoda-gun; Takuma-mura & Mukaijimanishi-mura in Mitsugi-gun; and Kamikamagarijima-mura & Kurabashijima-mura in Aki-gun.
- (22) Ôshima-gun, Kuga-gun (south), Kumage-gun (south), & Saba-gun (south).
- (23) Yokose-chô, Ikuhina-mura, & Takara-mura in Katsuura-gun; Kuwano-mura in Naka-gun.
- (24) Nio-chô & Gogô-mura in Mitoyo-gun; Matsuyama-mura in Ayauta-gun; Shimokasai-mura in Kagawa-gun; and Sogô-mura & Zentsûji-chô in Nakatado-gun.
- (25) Onsen-gun, Kitauwa-gun, Ochi-gun, Nishiuwa-gun, Iyo-gun, Higashiuwa-gun & Uma-gun.
- (26) Kagami-gun, Takaoka-gun, Agawa-gun, Nagaoka-gun, Aki-gun, Hata-gun & Tosa-gun.
- (27) Yame-gun, Kasuya-gun, Mii-gun, Ukiha-gun, Yamato-gun, Munakata-gun & Itoshima-gun.
- (28) Tamashima-mura, Kiuraki-mura, Nanayama-mura & Hamazaki-chô in Higashimatsuura-gun, Yamaguchi-mura in Kishima-gun, Kitataku-mura & Minamitaku-mura in Ogi-gun.
- (29) Ikiriki-mura, Nagayo-mura, Muramatsu-mura, Ôkusa-mura, Tokitsu-mura, Kikitsu-mura in Nishisonoki-gun; and Chiwata-mura & Miya-mura in Higashisonoki-gun.
- (30) Oama-mura in Tamana-gun; Kawachi-mura, Matsuo-mura & Yoshino-mura in Hôtaku-gun; Miyaji-mura, Kôda-mura, Kamimatsukuma-mura & Shimomatsukuma-mura in Yatsushiro-gun; Minamata-chô & Hinaku-chô in Ashikita-gun; Ôta-mura & Misumi-chô in Udo-gun; Kaitô-mura in Shimomashiki-gun; and Shikaki-mura, Shimoura-mura & Kutama-mura in Amakusa-gun.
- (31) Kitaamabe-gun, Minamiamabe-gun, Hayami-gun, Higashikunisaki-gun, Nishikunisaki-gun, Ôita-gun & Ôita-shi.
- (32) Higashiusuki-gun, Minaminaka-gun, Miyazaki-gun and Higashimorokata-gun.
- (33) Tarumidzu-chô in Kimotsuki-gun; Taniyama-mura & Nishisakurajima-mura in Kago-shima-gun; Kamitôgô-mura in Satsuma-gun; and Fukuyama-mura in Aira-gun.
- (34) Kunikan-gun.

*Possible beginning of cultivation*

- (1) Before Meiji 45 (1912).
- (3) M. 20 (1887).
- (4) M. 21 (1888) at Miyakejima.
- (5) 150 years ago.
- (6) 20 years ago.
- (7) 50 years ago.
- (9) M. 5 (1872).
- (10) During Tempō period (1830-1844).
- (11) Kōkwa 3 (1846).
- (12) Early part of Meiji (before about 1880).
- (13) During Kwan'ei (1624-1644).
- (14) Early part of Meiji.
- (15) A period between 140-150 years ago (according to "Mikan no Kishū" edited by Kanehiko ASAKURA, dated S. 5, 1930.).
- (16) 70 years ago.
- (17) Some time between 200 and 300 years ago.
- (19) During Bunsei period (1818-1830).
- (20) M. 38 (1905).
- (21) 260 years ago.
- (22) During Kaei period (1848-1854).
- (23) During Kwansei period (1789-1801).
- (24) M. 20 (1887).
- (25) 200 years ago.
- (26) M. 30 (1897).
- (27) Teikyō 1 (1684).
- (28) 150 years ago.
- (29) 150 years ago.
- (30) 80 years ago.
- (31) 200 years ago.
- (32) 300 years ago.
- (33) 30 years ago.
- (34) Taishō 9 (1920).

*Notice:* All data were furnished by prefectural authorities, and no correction was made.

*Approximate date of Satsuma boom from which the present activity commenced*

- (2) M. 40 (1907).
- (3) M. 37-38 (1904-1905).
- (5) T. 14-15 (1925-1926).
- (9) T. 6 (1917).
- (10) M. 28 (1895).
- (11) M. 37-38 (1904-1905).
- (12) From the end of Meiji Era to the beginning of Taishō Era (probably year around 1912).
- (14) M. 37-38 (1904-1905).
- (16) T. 3-4 (1914-1915).
- (17) M. 37-38 (1904-1905).

- (19) M. 40 (1907).
- (20) M. 40 (1907).
- (21) M. 28 (1895).
- (22) S. 3-4 (1928-1929).
- (23) M. 38 (1905).
- (24) M. 43 (1910).
- (25) Between M. 20 (1887) and M. 34-35 (1901-1902).
- (26) M. 36 (1903).
- (27) T. 8 (1919).
- (28) T. 14-15 (1925-1926).
- (29) M. 27-28 (1894-1895).
- (30) Between M. 27 (1894) and M. 44-45 (1911-1912).
- (31) M. 40 (1907).
- (32) T. 2-3 (1913-1914).
- (33) 4-5 years ago.

*Notice:* All data were given by prefectural authorities.

## HISTORY OF INTRODUCTION OF THE SATSUMA INTO THE UNITED STATES

According to TABER<sup>(11)(131b)</sup>, the Satsuma was first introduced into the United States by Dr. George R. HALL in 1876. Just after this introduction, General VAN VALKENBURG, then United States Minister to Japan, brought in another tree in 1878, and Mrs. VAN VALKENBURG gave the name "Satsuma", after the name of the province which took a major part in the movement of the Meiji restoration. There seems to have been subsequent importation from Japan since that time, and various names were given to the plant, like "Kii seedless", "Unshiu", "Oonshu", etc. etc.<sup>(4)</sup> At an early stage of development, the Satsuma was budded on sour or sweet orange stocks, but its merit really became recognized after it was propagated upon trifoliate stock. The latter (*Poncirus trifoliata* RAF.) came into actual cultivation about 1885, and started an epoch in the further development of Satsuma cultivation. The real boom did not come, however, until about 1908, when direct importation of the Satsuma trees in quantity became realized. Mr. S. IMURA\*, Alvin Nursery Co., Grand Bay, Ala., gave the writer the following information as to the extensive introduction from Japan.

In the season of 1908-1909 the plants mostly came from the nurseries

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\* According to a letter dated Nov. 12, 1917,



of Ikeda and in the following season of 1909-1910, one-half of the plants came from Ikeda but the other half from the nurseries of Owari. In the 1910-1911 season, about two-thirds of the plants came from Owari and one-third from Ikeda, but in the next and last season of 1911-1912, the plants were almost exclusively from Owari. Mr. S. ARAI of the Alvin Japanese Nursery Co., Alvin, Texas, made these importations through agents employed in Japan, but later he organized the Naigai Shubyō Kaisha to facilitate such importation. The Yokohama Nurseries Co. also made direct shipments during this period, but the shipments were mostly consigned to big nurseries. No definite figures of the amount introduced is known, but as the result of investigation in Japan, the writer found the following. This information is mostly based upon the statement of K. YAGI, who propagated the largest number of plants sent to America.

In 1908, Mr. YAGI sold 40,000 plants to the Ikeda nurseries, and Mr. B. KUBO of Ikeda sold Mr. ARAI about 100,000 plants, while the latter bought a similar number of plants also from Owari. This totals about 240,000 plants which crossed the Pacific during the season 1908-1909\*. Due to the difficulty in obtaining uniform plants at the beginning, the plants sold by YAGI was of such a mixture that 10% were grafted on the Yuzu (*Citrus junos*), not on the trifoliolate. In the next year, about 130,000 plants were sent out from Owari, while more plants were shipped from Ikeda. In 1910-1911, about 250,000 plants were sent out through Mr. ARAI, but the Yokohama Nurseries Co. shipped about 30,000 trees independently. About 80% of the plants shipped this year were propagated by using local scions, but 20% were based upon scions secured from Ikeda. In the last season, only about 50,000 plants went out from Owari. These were fumigated at the Government Experiment Station, Nishigahara, Tokyo, before they were sent out, and the trees were largely planted in the Grand Bay section in Alabama. Mr. YAGI estimates that about one million plants went to America throughout this period.

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\* See also the statement of Aichi-ken Engei Yōran (Horticultural Report of Aichi Prefecture). ed. 2. 1910, p. 106-108,

## **BOOK II**



## TAXONOMIC STUDIES IN THE SATSUMA ORANGE

### DESCRIBING THE CITRUS FRUIT

The botanical descriptions of most Citrus fruits do not meet the requirements of critical investigation. Ordinary technique for the description of plants gives only the outline of the plants even when such description grasps the most essential points. It requires special anthology and carpology to bring closely allied Citrus fruits into clear distinction. The author has attempted to outline such a technical descriptive method\*<sup>(195)(196)</sup>, although the success of any description rests chiefly on the experience of the describer. It became, however, very clear that certain characters, which are generally overlooked by the average botanist, occupy the most essential position in the identification of Citrus fruits, especially in naming the very numerous members of the so-called Mandarin group. Such points are given below, for example:

1. Tree habit; whether upright, moderately spreading, or widely spreading with round top.
2. Leaf texture and prominence of the vein and reticulation.
3. With or without paniculate inflorescence: If solitary or fascicled, the length of pedicel.
4. Shape of flower buds; oblong to round.
5. Calyx lobes: Shape, swelling and dotting, ciliation on the margin, pubescence (or glabrous surface), continuity to the pedicel.
6. Filament tube: Stamens, length as compared with style, coalescence, spreading at the end; thickness of the individual filament, especially at the apex.

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\* TANAKA, Tyōsaburō. Nippon Kankitsu Shuruigaku (Taxonomy of the Citrus fruits) Inaugural Dissertation of Tokyo Imperial University, 1910. MSS. 256 fol., illus. Appendix: Nominia Citrorum in Japonia et Formosa coluntur.

7. Shape and size of anther.
8. Shape and length of style: Shape and size of stigma.
9. Fruit shape: Convexity or concavity, of base and apex; shape and distribution of oil cell dots.
10. Fruit section: Thickness and color of rind layers; size and contents of the central column; number and shape of the segments; thickness and adherence of segment wall; arrangement of pulp vesicles.
11. Pulp vesicles: Whether attached to side wall (stand on side), or base; shape and size; length and strength of the stalk; strength of vesicular wall.
12. Seed characters: shape and size; pattern or striation on the surface, color and thickness of testa, color of tegmen especially at the charaza end; color and number of embryos.

Besides insufficient description and imperfect herbarium specimens, difficulty in *Citrus* classification has been often caused by the lack of reference to the locality where the plant was collected, or even by an entire lack of the specimen<sup>(18)(19)</sup>. Through the absence of training in taxonomic botany, most of the horticulturists or dendrologists who have studied and named *Citrus* fruits, have not given the definite place of growing, or even preserved botanical specimens. The writer suggested<sup>(12)</sup> that all botanical specimens in the future must bear the name of the locality where they were collected, and that the place where specimens are permanently deposited must be indicated in the original description.

The following description of the Satsuma orange is based upon both living and herbarium specimens of the plant cultivated in the Prefectural Agricultural Experiment Station at Nakagawa-chô, Nagasaki, Japan, now called the Citrus Sub-Station after the removal of the headquarters to Isahaya, Nishisonoki-gun. This material was considered the nearest possible to the original plant and to the place of permanent cultivation. The herbarium specimens are deposited in Tanaka Herbarium, at the Horticultural Institute, Taihoku Imperial University, Taihoku, Taiwan, Japan.\*

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\* All materials consulted by the writer will be listed in his critical monograph of Rutaceae-Aurantioideae, now under preparation.

## VEGETATIVE ORGANS

The tree has few main branches moderately expanding toward the head, which is usually tall and round, and not commonly disturbed by an irregular outgrowth of suckers. Trunks are smooth, light brownish-gray in color, with swollen base, when grafted on trifoliate orange, usually forked once or twice at the lower part, the number of branches gradually increases toward the center of the tree. The leading branches are comparatively few in number, mostly made by the natural forking of the trunk and are not decidedly distinguishable from the latter. They arise mostly from an undeterminate location on the tree, large, strong, heavy, and terete, absolutely lacking thorns; their inclination is moderately inclined outward, rarely horizontal, but in most cases they are rather upright. Productive branches or branchlets (leafless shoot) are not numerous, are rather strong, more or less conspicuously elongated, dark-colored, terete, and devoid of spines; their inclination is upright in the center of the tree, but slanting, horizontal, or even drooping on the side of the tree. Suckers or water sprouts are exceedingly elongated, from upright to drooping, irregular in shape and direction, and their number is limited in the bearing year. Biennial shoots of fruit-bearing wood (leafy shoots) are long, angular, dark-green in color, rather soft, loosely leaved with rather long nodes. Fruit stalks (peduncle plus pedicel) are very short, thick, terete, grayish in color, bearing only one fruit, not branching.

The foliage covering the tree is not crowded, so that the center of the tree is rather open and devoid of crowded pocket branches. Total number of leaves is not abundant; they are rather upright in the upper part of the tree, but always more or less hanging in the lower part of the tree unless the plant is in an unfavorable condition. The size of the leaves is large, often becoming very large. The surface of the leaves is dark green, flat and often somewhat undulate, never becoming boat-shaped and no considerable inward rolling is noticable; the texture is leathery, strong and elastic, but is not stiff and brittle. The outline of the leaves is lanceolate, tapering toward the apex, ending with sharp pointed tip,

narrowed to the base ending with straight or concave margin. The crenation of the margin is indistinct, apart and irregular. Venation is strong and distinct; mid-rib strongly projecting on both surfaces, lateral veins strong and few in number, rather acute-angled to the mid-rib, lowermost one more acute than others, moderately and gradually curved. Petioles are long, linear, with fringed, very narrow wings attached to the base of the mid-rib, where it is truncate in shape.

### THE FLOWER

Flowers are axillary or, rarely, terminal forming no inflorescence, two to five in a fascicle or solitary, standing on a separate peduncle, which may be leafy, but is generally very much contracted. The pedicel is articulated to the peduncle, continuous to the calyx, gradually broadening toward the apex, angular in cross section. Flower buds are cylindric, bluntly pointed and often emarginate at the apex, straight below, not swollen in the middle, surface smooth or deeply grooved. The flower calyx is cupulate, with moderately open end, and rounded base; the surface is deep green and glazed, slightly wrinkled, with small, sparse, rather inconspicuous oil cell dots; calyx lobes deeply cut, rather uniform and long, elongated-triangular with acutish-acuminate apex and round-mouthed at the base, only slightly ciliate at the tip of the margin. The corolla is medium in size (in comparison with other *Citrus* flowers), almost regularly astellate, wide open, invariably 5-petaled (except in the late bloom), pure white, fragrant, odor simple and sweet, nectar pleasantly sweetish. The petal is expanded, very often recurved, but not strongly reflexed, the tips somewhat pointing inward, lanceolate or almost linear, long and rather narrow, strongly boat-shaped or muller-shaped, striate inside; the apex of the petal is acute, base gradually narrowed, straight; oil cell dots rather sparse, small, light greenish and evenly distributed. The stamen is short, the filament rather thin, nearly straight, forming a thin cylindric tube without any expansion at the upper part. The anther small, rather irregular in shape, ellipsoid,

often asymmetric, caudate or sharply pointed at the apex, very conspicuously out-curved, usually devoid of viable pollen grains. The pistil is very slender, seated on round, cushion-like disk plate. The style is very long, far longer than the filament, terete, rather thin, slightly bowed or curved, pale green in color, sometimes slightly thickened toward the apex. The stigma is comparatively small, capitate, globose or depressed-globose, smooth, its section being round or elliptic. The ovary is small, obovate, or nearly globose, notched at the apex, smooth and light green. The locules are about 10, containing many biseriate ovules. The disk is flat, almost as broad as the ovary, medium high, margin nearly even, cream-white.

### THE FRUIT

The fruit ripens from October to November, is abundant, globose to low oblate-obovoid, usually depressed-globose, rarely somewhat conical or even slightly pear-shaped, of medium to heavy weight; the size of the fruit is medium to medium large, attaining to a considerably large size for a mandarin. The rind is elastic, compact or soft, smooth or uniformly pitted, bright orange or yellow in color, glazed to some extent, but never oily in appearance. The oil cell dots are not very distinct, at least dimorphic, large ones uniformly and moderately diffused, convex or concave, not prominently or even sparingly sharp pitted, frequently flat or only slightly convex, the color contrast of the dots with the ground substance of the peel is not distinct, except in very thin-peeled, extremely polished, smooth fruits borne under the shade of the leaves. The apex of the fruit is more or less flattened, or deeply depressed, with or without a distinct aleolar ring and open navel marking; the stylar point not positively protruding nor distinctly sinuate, often lacking oil cell dots around the point. The base of the fruit is flat, sinuate, broadly depressed or crater-like, with the disk concealed under the calyx, having a distinct border line against the peel. The calyx is large, deep green, more or less wrinkled or swollen, with a well developed tube portion and thick pedicel. The calyx lobes are well developed, usually



not uniform in shape, sharp pointed or sometimes elongate acuminate, often one changing into a leaf-like linear piece.

Halved fruit has no peculiar aroma, and simply possesses a honey-like odor. The rind is usually thin, elastic, with medium-sized, uniformly globular, not crowded, oil cells; the inner layer of the rind is fibrous or raggy, whitish with an orange hue, not usually pithy but occasionally so. The central column is comparatively large, not necessarily lying at the very center, and usually more or less elliptic, with a small amount of soft white pith and inconspicuous fiber strands. The segments are usually 9 to 13, not uniform in size and shape; the outer margin is parallel to the outline of the rind, is not distinctly emarginate at the center, the corner of the segment is only slightly rounded; the inner ends free from one another or often two or three in a group fastened by the pith, bluntly pointed, rarely mamillate; the segment wall is coriaceous or papery, usually thin and soft, but not easily torn or broken by separating the segments, whitish, not very translucent. The pulp is meaty, soft, with plenty of juice, orange colored, sweet, pleasantly grape or honey flavored, very slightly acid or almost non-acidic, keeping well without changing flavor or developing an unpleasant secondary flavor at a later stage of storage. The arrangement of the pulp vesicles is fairly parallel, they are salmon-flesh shaped or reticular, and the dissepiment of the vesicle is not distinctly seen. Individual pulp vesicles removed from the segment are small, numerous, uniform, almost regularly fusoid, thin walled, not very easy to separate from each other, more or less angular, long pedicelled or sessile, practically none are attached to the segment wall; pedicels are thin and weak; the wall is durable despite its thinness, and contains plenty of meat. Seedless (parthenocarpic). The seed, if present, rather large, round, and plump, only shortly beaked at the apex, the surface is a light capucine yellow, smooth, not mucilaginous, very faintly striated; several embryos are in one seed, the cotyledons are creamy-white, in smaller embryos often green; the testa is thin, coriaceous, somewhat translucent, the tegmen light colored, not intensely colored at the charaza part.

## ESSENTIAL BOTANICAL CHARACTERS OF THE SATSUMA ORANGE

The Satsuma tree looks entirely different from any other kind of Citrus tree. Well shaded, vigorously growing, at the age of about 25 to 30 the tree looks somewhat like a shaddock tree or a sweet orange tree, but the trunk is not so upright and the head is low, broad and more flat. The branches often make very random growth, giving the tree a very irregular shape. The branches never have the bushy habit, as many kinds of loose skin orange trees do, and they never show a conspicuous upright growth. The number of the branches is also very much limited, and they are strong and elongated. The leaves are always thick and dark colored, and in well nourished trees, the surface of large leaves is always buckled. The ends of the leaves are always acute, and the smaller leaves have generally a tapering base. The petiole is always linear and the wing is only rudimentary, having an equal width throughout. The wing never develops in vigorous growth, but the articulation to the lamina is always distinct, never becoming confluent.

The floral characters of the Satsuma orange are quite characteristic. The flower is much larger than in the other kinds of loose skin oranges, but is distinctly smaller than that of the sweet orange, especially it is smaller in calyx, anther, and ovary. The general nature of the flower is undoubtedly that of the type of loose skin oranges, and its solitary or fascicled flowers, not forming an inflorescence, make a definite demarcation from the sour-and-sweet orange group (Section *Aurantium* TANAKA)<sup>(155)X(190)X(184)</sup>. Its unusually long style is very remarkable, and the comparatively short filament, associated with degenerating anthers, is also unique. The shape of the calyx is somewhat similar to that of the sweet orange, but this is only an analogy since the calyx of the lemon also approaches that of the sweet orange, without having any taxonomic meaning. The characters of the fruit are very distinct from those of all of other loose skin oranges. Primarily, the amount of the pulp-ball is decidedly large, the fruit having a thin skin and a smaller central column. The pulp itself is meaty, soft, keeps long, and is sufficiently

juicy. In cross section, the demarcation of the pulp vesicles is faint, which means that the raggy substance is small in amount when tasted. The vesiculation, or the arrangement of the vesicles, is fine and elongate-anastomose, not often being parallel nor pentagono-anastomose. The color of the pulp is Cadmium orange\*, almost approaching Salmon orange. The flavor of the pulp is sweet, and is of a mildly refreshing quality, although it is pleasantly honey-like. The acidity decreases very rapidly on approaching maturity, and pulp tends to become insipid, especially when the fruit is kept long on the tree. Seeds are usually wanting, but through cross pollination or under certain conditions favoring apogamic seed formation, a limited number of seeds are formed<sup>(71b)</sup>. These seeds are always plump, not flat, are pointed at the base, thin coated, containing cream-green pale embryos always numbering more than two. The color of tegmen at the charaza is slightly tinted a somewhat buff-pink, but the other part of the tegmen remains a very light color.

### COMPARISON WITH THE CLOSEST RELATIVES GROWING IN JAPAN

Only two other kinds of loose skin oranges closely related to the Satsuma grow in Japan. The first is the Kunembo (*Citrus nobilis* LOUR.) and the other is the Yatsushiro (*Citrus yatsushiro* HORT.) A comparative study of the Satsuma and these close relatives gives us more light in clearing up their true status. The fruit of the Kunembo has been known since the beginning of the TOKUGAWA period. It is stated that the fruit of the Kunembo was presented to Iyeyasu TOKUGAWA from Kyoto in Tenshō 11 (1583)\*\*, and later it was commonly used, as seen in old dietetics\*\*\*. It was called the Kunebu in Kagoshima Prefecture, but it is unquestionably derived from the Kunibu of Luchu, where it is abundantly raised. The Luchu word "Kunibu" or "Funibu,"

\* The nomenclature of colors is based upon RIDGWAY's Color Standards and Nomenclature. Washington, D. C., published by the author, 1912.

\*\* See Ōtsuki, Fumihiko. Kinko Shidan Genbunshū (Collection of original texts from which Kinko Shidan was compiled) Tokyo, 1910. p. 119.

\*\*\*See Anonymons. Waka Shokumotsu Honzō (Dietetic herbal in verse). Kyoto. 2 books. 1642. Bk. 1. fol. 23.

applied not only to this kind but to all Citrus fruits, is undoubtedly Indo-Malayan "Nimbu," with accentic "K", or "F", at the beginning. "Nimboo" or "Limboo", from which Lime, Lemon, and Lumie are derived, is a general name for Citrus fruit, and the fruit reached Luchu from Malay, brought with many other things by Malaysans<sup>(183)</sup>. MATSUMURA refers the name "Kunembo" to "Kumla Neboo" of Hindostani, and "Kamla Nemboo" of Nepal\*, without reference to the actual specimen, but the writer identified it with the Indo-china species, as stated later. The Yatsushiro, on the other hand, does not occur in any other country, and only slightly resembles the Djerook Limoh (*Citrus amblycarpa* OCHSE) of Java. It is cultivated to a certain extent in Wakayama Prefecture as a substitute for the Kinokuni. Its fruit is so much like that of the Satsuma that irresponsible retailers sell the fruit as Satsuma. Hasty buyers learn the truth by cutting the fruit, which is seedy and has a poor taste. The origin of the Yatsushiro is unknown, but as the name indicates, it must have come from Higo Province, also the home of the Satsuma. This seems to be most likely a chance seedling of the Kinokuni. A comparison of the Satsuma, the Kunembo, and the Yatsushiro was made in Nagasaki Station, where these three are grown side by side\*\*.

### TREE CHARACTERS

In having a well-rounded crown and spreading growth, the Satsuma, the Kunembo, and the Yatsushiro are all alike. In the Yatsushiro, the mode of branching rather resembles that of the Kinokuni mandarin, while in the other two it is quite characteristic. In the Satsuma, the leading branches are very large and strong but few in number. The direction of these leaders in the Satsuma is upright or slightly inclined outward and is very rarely horizontal. In the Kunembo, such leading branches are much smaller, yet they are strong enough to spread hori-

\* See MATSUMURA, Jinsô. Futsû Shokubutsu (Common plants). Tokyo, 1901. on p. 417.

\*\* The author acknowledges the efficient cooperation of Prof. Taiji MIKI, formerly Director of the Nagasaki Station.

zontally; their number is more numerous than in the former. In the Yatsushiro, similar branches are put forth at random in every direction; they are rather strong but do not look as vigorous as those of the Satsuma, nor as stout as those of the Kunembo. Branchlets, or shoots, are very numerous and weak in the Yatsushiro, and many of them are upright, almost like those of the Kinokuni, if they are closely compared. In the Kunembo, the branchlets are numerous but they are stout and strong, not differing much from the habit of the leading branches; they are rather upright on the average. The branchlets of the Satsuma are quite characteristic; they are very vigorous, slender, and are not so stout as those of the Kunembo, the number of such shoots being few, irregularly sent forth, and often bent down to form drooping branches. Young shoots in the growing stage are longest in the Satsuma, without having any restriction as to the terminal elongation. In the Yatsushiro they are medium long, the growth is also not stunted in the early spring. In the Kunembo, the growth of new shoots is quickly terminated, only a limited number of lateral buds are developed.

### LEAF CHARACTERS\*

In comparing fully developed leaves, the Satsuma are largest, the Kunembo come next, and the Yatsushiro are the smallest. The comparative breadth of the leaves (breadth-length ratio) is just opposite in order—the Yatsushiro are broadest, the Satsuma last. The outline of the leaves is lanceolate in Satsuma, oblong in Kunembo, and ovate in Yatsushiro. The leaf-base is most rounded or obtuse in Kunembo, obtuse or slightly acute in Yatsushiro, and acute in Satsuma. The leaf-apex is also roundish in Kunembo, roundish or pointed in Yatsushiro, and pointed in Satsuma. The outline of the leaf margin near the base is always convex in Kunembo, usually convex or sometimes straight in Yatsushiro, concave, straight, or rarely convex in Satsuma. The curvature of the marginal line near the apex is almost always convex in Kunembo, convex or straight in Yatsushiro, and nearly always

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\* Compare PL. I. Figs. 1-3.

tapering in Satsuma. The very tip of the leaf-apex is much frequently emarginate in Kunembo, only sometimes so in Yatsushiro, and almost always not so in Satsuma. The crenation of the margin is finest and most distinct in Yatsushiro, slightly apart and less marked in Satsuma, and most apart and almost indistinct (especially in small ones) in Kunembo. The midribs of the Satsuma leaves are thick and distinct, while they are medium thick in Kunembo and are slender in Yatsushiro. On the upper surface they are very prominent in Satsuma, rather conspicuously raised in Yatsushiro, and rarely raised or slightly convex in Kunembo. The midrib in the lower surface of the leaf in the herbarium specimens is always slightly rugose in Satsuma and Kunembo, but is smooth in Yatsushiro. The angle of contact of the side veins to the midrib is almost uniform in Kunembo and somewhat irregular, often very narrowed at the base in Satsuma and Yatsushiro. The thickness of the leaves is much the same, but the leaves of Satsuma are thickest, of Kunembo not so thick and of Yatsushiro thinnest. The surface of the leaves is smooth and flat in Yatsushiro and Kunembo, but more or less undulate or buckled in the large leaves of Satsuma. The Kunembo leaves are most rigid in texture and very often their margin is strongly recurved inward on the upper surface. The Yatsushiro leaves, on the contrary, are usually muller-shaped, or in other words, they are V-shaped in a tranverse cross section. The comparative length of petiole to lamina is longest in Satsuma, medium in Yatsushiro, and shortest in Kunembo. The shape of the petiole is entirely different in each case. In the Satsuma, it is fringed only to the midrib, while it is distinctly obovate in the Kunembo, cuneate in the Yatsushiro. The wings of the Kunembo are very narrow and become almost rudimentary, but in the Yatsushiro they are distinct except in abnormal cases. They are long and reach to the lowermost end of the midrib in the Yatsushiro, but are short and characteristically end at the middle or at one-third from the base, in the Kunembo. The upper corner of the wing is always rounded in the Kunembo, while it is almost triangular in the Yatsushiro, often showing a tendency to become confluent to the lamina.

## FLORAL CHARACTERS

The flowers of the Kunembo, the Yatsushiro, and the Satsuma closely resemble one another. They have a medium sized corolla, lanceolate petal, with acute apex and gradually narrowed base, the oil cells of which are small and faint. The pedicels are equally short and gradually broaden toward the apex. The difference in detail is as follows. The shape of the unopened buds\* is oblong-obovoid in Kunembo, elliptic-obovoid in Yatsushiro and cylindric in Satsuma. The broadest part of the bud in Kunembo lies not far from the middle, in Yatsushiro it comes near the shoulder, but in Satsuma it is variable, almost undeterminable. The apex of the bud is bluntly pointed in Kunembo and Satsuma, but rather rounded in Yatsushiro; the base of the bud is straight in Satsuma, gradually narrowed in Kunembo, but abruptly narrowed in Yatsushiro. The side of the bud is nearly straight in Satsuma, almost straight in Yatsushiro, slightly curved in Kunembo; the suture lines of the petals on the surface of the bud are inconspicuous in Kunembo, rather inconspicuous in Yatsushiro and Satsuma; the junction of the suture lines at the apex of the bud is not emarginate in Kunembo and Yatsushiro, but is often emarginate in Satsuma; the surface of the bud is almost uniformly shallow-grooved in Yatsushiro, nearly smooth, or with some petals shallowly grooved, in Kunembo, while deeply grooved, at least in several petals, in Satsuma. The shape of the calyx in the bud is cupulate in Kunembo and Satsuma, but is scutellate in Yatsushiro; its base is rectangular in Kunembo, narrowed in Satsuma, rounded in Yatsushiro, its upper ends are very slightly open, conspicuously open, and moderately open, respectively. The surface of the calyx is rather smooth, glazed and deep-colored in Satsuma, practically smooth, a little glazed and light-colored in Yatsushiro, and rugose, a little glazed and light-colored in Kunembo. The angles of the calyx lobes are shallow in Kunembo, deep in Satsuma and deepest in Yatsushiro, consequently the calyx lobes assume a quasi-triangular, triangular, or elongated-triangular shape, respectively. The comparative height of the

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\* See Pl. I. Fig. 4.

calyx lobes is short or sometimes only dentate in Kunembo, medium in Yatsushiro, and somewhat longer in Satsuma. The shape of the mouth at the base of each lobe is simply rounded in Satsuma, rounded or rather open in Yatsushiro, rounded or occasionally acuminate in Kunembo; shape of the apex of the calyx lobes is in each case subacute-acuminate. The calyx tube (body) is slightly wrinkled in Kunembo and Satsuma, but nearly smooth in Yatsushiro. Oil cell dots on the calyx surface are rather inconspicuous in Kunembo and Satsuma, but slightly more conspicuous in Yatsushiro; in Kunembo they are fairly closely spaced, small, rather deep and give a rough appearance to the surface; in Yatsushiro and Satsuma they are rather sparse, small, practically flush and not affecting the smoothness of the surface. The pedicel in Kunembo is roundish in cross section, but angular in Yatsushiro and Satsuma; its upper end is rather continuous to the calyx in Satsuma, but is somewhat notched in Kunembo and Yatsushiro. Petals are all wide open at the blooming, but expand only in Satsuma, explanate in Kunembo and Yatsushiro; the mode of horizontal expansion of each petal is often recurved in Yatsushiro, very often recurved, but the tip sometimes pointing inward, in Satsuma, while in Kunembo some are recurved but almost all are conspicuously reflexed in the majority of cases. The transverse curvature of the petals is slightly flat or slightly boat-shaped in Yatsushiro and Kunembo, but is very deeply boat-shaped in Satsuma; oil cell dots on the surface of the petals are rather sparse in Yatsushiro and Satsuma but medium dense in Kunembo. Stamens are in all cases shorter than the style but are extremely so in Satsuma, the stamen tube is thick in Yatsushiro, somewhat thick in Kunembo, but more slender in Satsuma, and it is slightly enlarged toward the apex in Kunembo, but not so enlarged toward the apex in Yatsushiro and Satsuma. The filaments are nearly straight in Kunembo and Satsuma but are curved at the base in Yatsushiro, they are thinnest in Yatsushiro: Anthers of Satsuma are small, devoid of healthy pollen, rather irregular in shape, ellipsoid or often asymmetric, and very conspicuously out-curved; those in Yatsushiro are medium small, oblong-ovoid, straight; those in Kunembo are medium sized, almost oblong and are



also nearly straight; the apex of the anther is round in Kunembo and Yatsushiro, but is sharply pointed with a caudate end in Satsuma. The stigma is globose or slightly cylindric in Kunembo, globose or depressed globose in Yatsushiro and Satsuma; the cross section of the stigma is round in Kunembo, round or elliptic in Yatsushiro and Satsuma, its size being largest in Yatsushiro. The style is similarly terete but most frequently curved in Satsuma. The ovary is subglobose in Kunembo, obovate in Yatsushiro and Satsuma.

### FRUIT CHARACTERS

The fruits are similar in size, flatness, and in the color of the rind, which is orange. The average size is probably largest in Kunembo and smallest in Yatsushiro. The shape is uniformly depressed globose in Kunembo, rather oblate-obovoid in Yatsushiro, and typically obovoid-globose in Satsuma, except in some flat forms. The rind is most glazed and oily in Yatsushiro, similarly firm but more or less granular russet in Kunembo, and smooth and elastic in Satsuma. Oil cell dots of the rind are uniformly small and sparse but always convex, often with a sunken demarcation in Kunembo, large, dense and prominent, often forming very sharp concave pits in Yatsushiro, moderately dense, medium large, convex, or concave, not causing much pitting, except in extra coarse fruit, in Satsuma. The fruit apex of Yatsushiro is most decidedly characterized by a deeply sinuate stylar end, such sinuation never occurs in Satsuma and Kunembo. The calyx of Satsuma has a well developed tube portion and its well developed calyx lobes are almost regular or slightly irregular in shape, while in Kunembo the lobes are almost regular, but smaller, with a comparatively large sized tube portion; this is very different in Yatsushiro, not only in the very regular, astellate calyx-lobes but also in the poor development of the tube portion.

The difference in a cross section of the fruit is much more striking. The newly halved fruit of Kunembo has a very strong, characteristic aroma, from which the adopted Sino-Japanese name *Kōtō* (*Hsiang ch'en*,

fragrant orange) is derived\*; a section of Yatsushiro also possesses a similar, but less pronounced, odor. In the Satsuma, such odor is entirely lacking. The rind is thick and hard in Kunembo and is edible; thick and brittle in Yatsushiro; rather tenacious and elastic in Satsuma, the latter two being too strong-tasting to eat. The pulp is very transparent and juicy in Kunembo, translucent and rather meaty in Yatsushiro, more opaque and meaty in Satsuma; the color of the pulp is deepest in Satsuma, Yatsushiro coming next, and lightest in Kunembo; the uniformity of sweetness in a number of fruits and the superiority of the flavor is highest in Satsuma, the other two being more variable in quality and rather insipid in flavor, under average conditions in western Japan, exclusive of Luchu, where Kunembo attains its highest quality. Kunembo keeps its juiciness fairly well but the acidity does not decrease to a palatable degree, while Yatsushiro turns fairly sweet in the late season, though it loses its flavor and juiciness rather quickly. In the Satsuma, the juice easily loses its acidity and keeps a good flavor for a long period without deterioration. The pulp vesicles of Satsuma are small, regularly fusoid as a rule, while in Yatsushiro they are larger and are irregularly ellipsoid, and in Kunembo they are largest and are more decidedly ellipsoid and angular. The seeds in Satsuma, when they are found, are always globose, plump, and have very little striation on the surface, but in Yatsushiro they are more elongated, never become plump even when rounded, and always have distinct striations on the surface, while in Kunembo they are very long and strongly beaked at the apex and have most distinct parallel striations, the color of the embryo is green in Yatsushiro, creamy-white in Kunembo and Satsuma; the number of embryos is fewest in Kunembo, in Yatsushiro there are more while they are

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\* The name Kôô, or Hsiang Ch'ên, is first mentioned in Êr Ju t'ing Ch'ün fang p'u, written by WAN Chin-ch'ên (in 4 parts, 28 books, compiled in T'ieg Ch'i Hsin yu, 1621), on fol. 44 B of Pt. 2, Bk. 2. According to Kinko Shidan (Historical narratives) written by Kankei ÔTSUKI (4 books. From 1882 ed. Bk. 3. fol. 9) the Hsiang ch'ên was first introduced by a Chinese of south Yang-ts'e province into Japan during the Tenshō period, 1573-1592, but curiously the name Kunembo was first mentioned in Tashikihen, written by Razan HAYASHI in 1612. The identity of Hsiang Ch'ên is therefore incorrect. HU<sup>(41)</sup> recently reports that the Hsiang Ch'ên he found in T'ang-chih in Chekiang Province was our *Citrus junos*!

most numerous in Satsuma; the color of the tegmen at the charaza is deepest in Kunembo, while Yatsushiro and Satsuma are equally lighter in shade; the placenta is very much eccentric in Kunembo, that is to say, the seeds are placed on the side walls of the carpel, while in the other two this characteristic is not noticeable.

### SYSTEMATIC POSITION OF THE SATSUMA, KUNEMBO, AND YATSUSHIRO

The above comparison makes it clear that the Satsuma, Kunembo and Yatsushiro are very closely related but still are entirely different. Both the vegetative and the reproductive organs of these three are similar, and they can be safely regarded as forming a group separate from other loose skin oranges, to which the sub-sectional name *Euacrumen* was given by the author<sup>(180)(181)</sup>.

Through a search in botanical literature, the Kunembo is found to be referable to LOUREIRO's *Citrus nobilis*, and this identification was confirmed after comparison with the King orange of America, known to have been imported from Cochinchina in 1880<sup>(307)</sup>, and the "Orange de Cambodge", described by GUILLAUMIN<sup>(36)</sup>. It was also collected from Annam, where LOUREIRO lived<sup>(187)</sup>.

The difference between Kunembo and King is only varietal, summarized as follows:

- (1) King has a smaller calyx with broad acuminate lobes.
- (2) Oil cell dots of King are smaller and their arrangement is much closer\*.
- (3) The seed of King is monoembryonic, while the seed of Kunembo is usually polyembryonic.

The leaf characters are exactly the same, having thick obtuse lamina, and short petiole with obovoid petiole wing. LOUREIRO states that the petiole is linear\*\*, and truly the wing often does not develop in King and

\* The apparent difference of the arrangement of oil cell dots is very often caused by the change of texture of the rind surface due to unusual conditions of the environment.

\*\* LOUREIRO, in *Flora Cochinchinensis* 2: 486 (1790), states "Differ. spec. *Citr. inermis*, ramis ascenditibus: *petiolis* strictis . . ." and in the diagnosis, he gives "*petiolis* linearibus."

can easily be overlooked, whenever some leaves do have it. The specimen collected by EBERHARDT at the apparent type locality, Hue in Annam,\* appears exactly the same as King, first described by TAYLOR<sup>(297)</sup>. Observations have been made in America, the Philippines, and other places where King is cultivated, and its remarkable identity with Kunembo was verified. The texture of rind, characters of the pulp and the pulp vesicles, the peculiarity of the seed and the seed attachment, every other detail of fruit and leaf characters, all agree one with the other. According to LOUREIRO<sup>(298)</sup>, the rind of *Citrus nobilis* is edible, and TAYLOR agrees that this is the case in King. In Japan, it is well known that the peel of Kunembo is edible\*\*, and this is almost an exclusive character among the loose skin oranges, as SWINGLE points out<sup>(128)</sup>. This group, comprising Kunembo, Yatsushiro, and Satsuma<sup>(136)</sup>, is clearly distinguished from other sub-arborescent mandarins having small leaves and small flowers. By having large plant parts, this group approaches Sect. *Aurantium*, which includes sour and sweet oranges, but the lack of inflorescence makes it clearly different from the latter, which is a descendent of the shaddock (Sect. *Cephalocitrus*), having distinct panicles.

## THE SCIENTIFIC NAME OF THE SATSUMA ORANGE

In the early botanical literature of Japan no scientific name is given to the Satsuma orange. An excellent monograph on Citrus given by the Imperial University of Tokyo<sup>(215)</sup> illustrates the Satsuma perfectly well, but it is erroneously termed *Citrus japonica*, a homonym of the present *Fortunella japonica* (THUNB.) SWINGLE. This identification is probably based upon FRANCHET & SAVATIER, who listed the Satsuma (Nakasima) under this specific name<sup>(32)</sup>. Baron TANAKA'S "Useful Plants of Japan"<sup>(296)</sup> also gives a good colored figure of the Satsuma but it is only named *Citrus nobilis* L. var. He says in the English description, "It

\* Specimens are in Natural History Museum in Paris. T. T. determination Nos. P 404, P 405 and P 406.

\*\* See FOUKOURA, Y. Kishû Kankitsuroku, p. 98 (1882); Hiroshima-ken Nôkwai. Nôji Chôsa, vol. 1, p. 22 (1902); etc.

has a thin skin, few seeds, and rich sweet juice. It is the best Japanese orange". MANASE<sup>(66)</sup>, in an English text accompanied by excellent colored charts of Japanese oranges, writes about the Satsuma, "It is mostly esteemed for its excellent quality for table use as well as for being seedless. One of the best." It lacks, however, any scientific name.

Among catalogues of plants of various botanical institutions in Japan, the earliest publication, the "Koishikawa Catalogue"<sup>(74)</sup>, gives "Unshiu-mikan" as "*Citrus* sp." The subsequent catalogue of the same garden<sup>(208)</sup> gives the name *Citrus Aurantium* L. var. *nobilis*, for Mikan, Tō-mikan, and Unshō-mikan. MATSUMURA, did not give any name to the Satsuma in his "Nippon Shokubutsu Meii", "Shokubutsu Meii", "Kaitei Shokubutsu Meii" (Japanese names of Plants), and "Shokubutsu Meikan" (Index Plantarum). The "Catalogue of the Educational Museum" also does not give the name. MAKINO in "Shokubutsu Dzukan"<sup>(62)</sup> gives *Citrus Aurantium*, L. subsp. *nobilis* MAKINO var. for the Unshō Mikan, but he did not give the varietal name. The writer<sup>(138)</sup> first proposed the name *Citrus nobilis* LOUR. subsp. *genuina* TANAKA var. *Unshiu* TANAKA, but SWINGLE mistook it for "*C. nobilis* subsp. *genuina* var. *unshiu* MAKINO" and proposed a new combination *Citrus nobilis*, LOUR. var. *unshiu* (MAKINO) SWINGLE<sup>(129)</sup>. MAKINO never used the subspecies name *genuina*, which was first given by the writer. In a recent publication, MAKINO, in joint authorship with NEMOTO<sup>(63)</sup>, described the Satsuma under the name "*Citrus Aurantium* var. *Unshiu* (nov. v.—*C. nobilis* var. *unshiu* SWINGLE)". This name *Citrus Aurantium*, var. *Unshiu* is adopted in MURAKOSHI's recent compendium<sup>(77)</sup>, written under MAKINO's influence. MAKINO's opinion is, however, not definite, because he adopted the name *Citrus Aurantium*, L. subsp. *nobilis*, MAKINO var. *Unshiu*, MAKINO in his flora written with Kōichi TANAKA<sup>(64)</sup>. SWINGLE regards the Satsuma as "a botanical variety distinct from the King (*Citrus nobilis*) and the Mandarin oranges." This opinion was later adopted by HAYATA<sup>(30)</sup>, but he made a liberal change in spelling the varietal name, i. e., *Citrus nobilis* LOUR. var. *Unshu*. MIQUEL<sup>(73)</sup> is perhaps the first botanist who described the Satsuma as a species, but he identified it as *Citrus nobilis*. The author has repeatedly suggested that the Satsuma is not a mere variety

of any other kind of orange, and first called it a "variety group" (according to the suggestion of Dr. William A. TAYLOR<sup>(149)</sup>), and later proposed a term "horticultural species"<sup>(147)</sup>, not differing from a botanical species but being simply of garden origin<sup>(152)(157)</sup>. This term is identical with "cultigen", given by L. H. BAILEY<sup>(16)</sup>, in contrast of "indigen", meaning wild species. The recognition of such species of garden origin is clearly mentioned in the "International Code of Botanical Nomenclature"<sup>\*</sup>, and the writer accordingly called the Satsuma *Citrus unshiu* HORT. in succeeding publications<sup>(149)(150)(152)(153)(172)(173)</sup>. Previous to the author's publication of the Satsuma in the species rank (1923), MARCOVITCH<sup>(67)</sup> had published the *Citrus unshiu* (MAKINO) MARC., maintaining that the Satsuma is a good botanical species. His publication was unfortunately unknown to botanists, because of being published in a local agricultural experiment station publication in the Black Sea region and being written exclusively in Russian. At his visit to the writer in 1926, the original publication first became accessible, and consequently the writer announced the validity of this nomenclature and adopted it in his later publications<sup>(160)(155)(192)</sup>. In a subsequent paper, MARCOVITCH<sup>(68)</sup> clearly stated that Prof. MAKINO named it *Citrus nobilis* LOUR. var. *Unshiu*, but this combination is not by MAKINO but by SWINGLE, and the authority of the name "Unshiu" in variety rank is not by MAKINO but by the writer, as mentioned above. His specimen, if it was present in his herbarium in Sukhum, was apparently seized by the Union of Soviet Republics, and is not available.

The formal citation of literature and the original description of the Satsuma is as follows:

*Citrus Unshiu* MARCOVITCH in Известия Сочинской Областной и Сухумской Садовой и Сельско-Хозяйственной Опытной Станции No. 2. P. 5, 1921.

*Citrus unshiu* HORT. ex TANAKA in Int. Rev. Sci. Prac. Agr. n. s. 1, p. 32 (1923).

*Citrus nobilis* LOUR. ssp. *genuina* TANAKA var. *Unshiu* TANAKA in Bot. Mag. Tokyo, 26, no. 306, p. 204 (1912).

\* See Règles internationales de la nomenclature botanique. Jena, G. FISCHER, 1912. Art. 42.

*Citrus nobilis* LOUR. var. *unshiu* SWINGLE in BAILEY, Stand. Cycl. Hort. 2, p. 784 (1915).

*Citrus nobilis* LOUR. var. *Unshû* HAYATA Icon. Pl. Formos. 8, p. 22 (1919).

*Citrus Aurantium* L. var. *Unshiu* MAKINO, in MAKINO & NEMOTO, Fl. of Japan, p. 667 (1925).

*Citrus Aurantium* L. subsp. *nobilis* MAKINO var. *Unshiu* MAKINO, in MAKINO & K. TANAKA, Man. Fl. Japan, p. 307 (1928).

*Citrus Aurantium* LINN. subsp. *Keonla* ENGL. in ENGL. & PRANTL, Pf.-Fam. 3 pt. 4, p. 199 (1897), pro parte.

*Citrus Japonica* THUNB. variat fructu rotundo, FRANCHET & SAVATIER Enum. Pl. Jap. 1, p. 74 (1875), nomen. (sub Nakasimahacan)

*Citrus japonica* K. ITÔ Iconog. Pl. Bot. Gard. Tokyo Univ. 3, no. 8, p. 23 (1886), non THUNB.

*Citrus nabilis* DC. var. *nagasima* SIEB. in sched. (pro parte).

#### ORIGINAL DESCRIPTION\*

12 10. *Citrus unshiu* (Makino) Marc. Мы  
решаемся его выделить в особый вид, ибо  
он отличается не только по внешнему виду,  
но и биологически от всех мандаринов. Так  
общий вид его раскидистый, ветви не ко-  
лючия, листья крупные, широкие, обрублен-  
но суженные к вершине с сильно выступаю-  
щими нервами с обеих сторон и узко-кры-  
латыми черешками. Размеры плодов сред-  
ние, форма округло-сжатая. Запах кожицы  
своеобразный, не похожий на все мандари-  
ны. Поспевание ранее, отсутствие семян или  
они единичны, кубарчатой, а не <sup>внешне</sup> ~~плоской~~ <sup>как</sup> ~~плоской~~ <sup>тен</sup> ~~плоской~~ <sup>ге</sup>  
той формы, как у других мандаринов. Кро-  
ме того он весьма устойчив против моро-  
зов. Имеются разновидности с большим ко-  
личеством семян.

\* The correction of the text was made by the original author, on the author's copy of the publication.

## SUBSEQUENT BOTANICAL DESCRIPTIONS OF THE SATSUMA ORANGE

The Satsuma orange has been collected from Japan by several exploring European botanists. It was not known to the first two great explorers in Japan, KAEMPFER and THUNBERG. No specimen of any kind of *Citrus* was found in KAEMPFER's herbarium folios in the Hans Sloane Collection deposited in the Natural History Department of the British Museum. Among the *Citrus* specimens of THUNBERG's herbarium of the University of Upsala, Sweden, no Satsuma was found. SIEBOLD, the third great explorer in Japan, is perhaps first who collected it in Japan. According to MIQUEL<sup>(74)</sup>, there are in the Rijks Herbarium at Leiden (1) 6 specimens of *Citrus nobilis* LOUR., (2) 2 specimens of "form. fol. minoribus", and (3) 1 specimen of "var.?" Actual examination of these specimens revealed the following facts: (1) The first sheet of *Citrus nobilis* LOUR., so written in MIQUEL's own handwriting, bears four branches of *Citrus*, the uppermost being Satsuma and the rest Kunembo. On the second sheet is mounted three branches of Satsuma. The third sheet contains 5 branches; the upper left and the lower right is Citron (*Citrus medica* LINN.) the upper right is Kunembo, and two lower are Satsuma. The Kunembo branch bears a characteristic Japanese label with SIEBOLD's own handwriting reading "*Citrus nobilis* DC. Pr. var. *nagasima* flor. Majo. 1829". This is apparently placed on the wrong branch, and should belong to the Satsuma branch below. The fourth sheet has four branches; the upper left is Kinokuni the lowermost two are Satsuma, and upper right is Kunembo. The Kunembo branch bears the SIEBOLD label reading "*Citrus nobilis* DC. Pr. var. *nagasima*" and one of the Satsuma branches bears also a SIEBOLD label, reading "*Citrus nobilis* DC. *Oosima*". In this case the labels were just transposed, because the Kunembo might have been called the Oosima Mikan, the name after the place where it is best known. The fifth sheet bears five branches of Satsuma, one of which bears the SIEBOLD label, reading "*Citrus nobilis* DC. Pr. var. *nagasima mikan*". The sixth sheet has three branches, all being Satsuma. (2)



The first sheet of those bearing the MIQUEL label written as "forma foliis minoribus MIQUEL" contains 7 branches. The upper left one has a label with Japanese letters reading "Maru-mikan, May 13th., the year of the boar", and together with branches of upper right and middle right is Kinokuni. A branch mounted on the middle left is Satsuma and it bears a label with Japanese letters reading "Nakashima mikan. May 13th., the year of the boar". The branch on the lower left is an ordinary sour orange (*Citrus Aurantium* LINN.) and that on the lower right is a variety of the same with a thick calyx. The second sheet, with a similar MIQUEL label, bears four branches of Hanayu (*Citrus hanaju* HORT., apparently a Yuzu Hybrid) and SIEBOLD's label attached to them reads, "*Citrus hanaju* flor. majo" and "*Citrus hanaju* J." (3) The last specimen with a MIQUEL label of "*Citrus nobilis* LOUR. *varietas*" has only one branch of Kunembo. Besides these specimens listed by MIQUEL as *Citrus nobilis* and its varieties, there is one other specimen named by him "*Citrus japonica* THB. forma?". This specimen bears a label written by SIEBOLD as "*Citrus nagasimamikan*. Jap." and three branches are mounted; one is Kinokuni but two others are Satsuma. Besides the SIEBOLD specimens of the Satsuma from Japan, there are two other Satsuma specimens in Leiden, one being from a collection of BAENITZ, and the other without the name of the collector. The latter may be the specimen collected by MOENIKE listed by MIQUEL. SIEBOLD, on the other hand, gives the following comment on Japanese Citrus species<sup>(116)</sup>.

"309. *C. nobilis*, LOUR. (DC) (v. v. h. b.)

Varietates Extant in Japonica, diversae, quae vero duabus comprehenduntur sectionibus :

- a. Mikan, cortice pomorum crassiori.
- b. Koozi, cortice pomorum leviori.

Quarum ipse vidi venales; a. nagasima-mikan; b. Ma-mikan; c. Tachibana; d. Wasekoosi; e. Sirokoozi, etc. etc."

This very rich material of the Satsuma orange was utilized by MIQUEL, and he first described the Satsuma under the name *Citrus nobilis*. The description seems almost exactly that of the Satsuma, not including its close relative, the Kunembo.

"*Ramuli* compresso-compressi glabri; petioli  $\frac{3}{4}$ -fere 1 poll. longi, antice obiter canaliculati et obsolete submarginulati: *Folia* elliptico-oblonga, ovato-obovate-elliptica vel lanceolato-oblonga, basi acutiuscula usque cuneata, apice acuta, acutiuscula, obtusa vel obtusoprotracta, 5-2 poll. longa, crenulata, costulis subtus distinctis subpatulis irregulariter venulosis: *Flores* axillares nunc *Pedunculo* brevi suffulti, singuli pedicellati, nunc obsque pedunculo 2-4 aggregati in ramulis brevibus microphyllis, foliisque caducis pedunculi multiflori as instar. *Calyx* profunde 5-dentatus vel -partitus. *Flores* maiusculi usque  $\frac{1}{2}$  poll.; *Petala* elliptico- vel lanceolato-oblonga. *Stamina* 20 vel pauciora, nunc vario modo coalita nunc libera. *Stylus* longiusculus.—Colitur in Iaponia, ubi *Nagasimo* vocatur."

Although SIEBOLD's specimens of *Citrus nobilis* are such a mixture, this description fairly agrees with the Satsuma, and the Japanese name *Nagasimo* is of course a typographic error of *Nagasima*, the name of the Satsuma in Nagasaki, as stated before.

MIQUEL also described "- var. ? folis nimoribus. Hanapi iap., alique parum diversa, quas *Osima-mikau* iap. dicta," and the former applies to the Hanayu (Hanaju of SIEBOLD, as quoted before), and the latter the Kunembo. Here are again two typographic errors, Hanapi is Hanaju, and mikau is mikan. SIEBOLD gives *Citrus kunep* for the Kunembo, but this is a synonym of LOUREIRO's *C. nobilis*.

After SIEBOLD, many Satsuma specimens were prepared by MAXIMOWICZ from Nagasaki, and his specimens were distributed with labels "Ex herb. horti bot. Petropolitani. Maximowicz iter secundum". ENGLER, determining this material, named it *Citrus Aurantium* L. subsp. *Keonla* ENGL. The Keonla cover in the Botanical Museum at Berlin-Dahlem contains this and other things, none agreeing with BONAVIA's *Citrus nobilis* var. *Keonla*<sup>(17)</sup>. ENGLER's description of the subspecies is: "mit meist ungeflügelten Blattstielen, länglichen, angeradeten und gekerbten Blättchen mit roten, nur in ganz reifen Zustange essbaren Fr." Among his specimens, one has a petiole wing and is referable to lime (*Citrus aurantifolia* SWINGLE), the second has a fringed wing, being a form of *Citrus limonia* OSBECK, and the third is wingless but is decidedly a form of lime, all collected in Africa, none of them corresponding to the description given by him. The remainder, the Satsuma specimen distributed by MAXIMOWICZ, is the only one agreeing with his description, although his description is based upon BONAVIA. It is interesting that the Satsuma was once referred to such a different Indian species of *Citrus* fruits.

The description of SWINGLE<sup>(128)</sup> is as follows :

"A small spineless tree, with a spreading dwarf habit: lvs. broad, abruptly narrowed toward the apex, with strongly marked veins on both faces: fls. small, very abundant: fr. depressed-globose, 2-3 $\frac{1}{4}$  in. diam., deep orange; pulp orange, very juicy, of a peculiar but agreeable flavor; pith hollow; segms. 9-13; seeds often lacking, when present only few in number, broadly top-shaped, not beaked as in the Mandarin oranges, greenish within."

MARCOVITCH's English description of his *Citrus Unshiu*<sup>(68)</sup> is as follows :

"*C. Unshiu* (MAKINO) MARC. Japan mandarin. Prof. Dr. MAKINO named it as *C. nobilis* LOUR., var. *Unshiu* MAK. We find that it is a very good botanical species. It has large spreading branches without thorns, large, broad, truncate leaves, narrow growing to the end of the branches, with pronounced veins on both sides and narrow winged petioles. The middle sized fruit is compressed roundish and has a peculiar smell, otherwise than the common mandarin skin. The seeds are not quite depressed, but topshaped. The common form has no seeds. It is an early (October) bearer and very vigorous."

The writer's abbreviated description of *Citrus unshiu*<sup>(155)</sup> is as follows :

"Spineless tree about 8 m. high. Leaves large, oblong, tapering at ends, petiole rather long, fringed. Petals moderately recurved. Fruit medium, oblate, orange-colored, oil cells uniform and close, rind thin. Pulp meaty, sweet, very deep-colored. Vesicles abundant, slender. Seeds, if present, plump, whitish and polyembryo pale green, generally seedless.

Originated in Japan. Sparingly cultivated in Taiwan, Luchu, California, Philippines and Java."

## POSSIBLE ANCESTORS OF THE SATSUMA ORANGE

As to the origin of the Satsuma orange, the writer has suggested that it is probably a new species originated through a chance seedling<sup>(157)(160)(192)</sup>. The origination of new species through chance seedlings is perhaps well shown in the case of grapefruit. In 1696, Hans SLOANE described the Shaddock (*Citrus grandis* OSBECK) from Jamaica, and in 1707, he mentioned the introduction of the Shaddock into Barbados<sup>(117)(118)</sup>. He never saw the grapefruit in the West Indies, and his specimens of *Citrus* in his celebrated herbarium in the British Museum do not include grapefruit. Only about fifty years after that, in 1750, Griffith HUGHES first gave a description of the "Forbidden Fruit Tree" from Barbados. This plant is the grapefruit, subsequently described by Patric BROWNE (1756), LUNAN (1814), RISSO & POITEAU (1818-22), TUSSAC (1824), MACFADYEN (1830, 1837), and others. The grapefruit is essentially different from the shaddock in its peculiar pubes-

cence on shoot and leaf, smaller flower, characteristic rind character, pulp vesicles and polyembryonic seed and many other points, which make it a distinct species, as HUME<sup>(44)</sup> and the author<sup>(184)</sup> independently concluded. The bibliographical reference gives a clue that the grapefruit was originated through a chance seedling within about fifty years after the mother species was established in Barbados. The Mediterranean mandarin (*Citrus deliciosa* TENORE)\* is another case of a chance seedling. The author's survey in China and later investigations failed to locate the true mandarin\*\* although it came originally from China. Its closest relatives, however, are, in existence all through China, among which Ponkan (*Citrus poonensis* HORT.), Kinokuni (*Citrus kinokuni* HORT.), Genshōkan (*Citrus genshokan* HORT.), and Suhoikan (*Citrus suhoiensis* HORT.) are to be mentioned as its probable parents. The Japanese Natsudaidai (*Citrus natsudaidai* HAYATA) comes also under the example of a chance seedling.

In Huangyen, from where the seed of the mother plant of the Satsuma probably came, the author found three Citrus fruits closely related to the Satsuma orange in fruit characters: The Pentitsao (Local Early orange), Mankieh (Late orange), and Tsaokieh (Early orange). The fruit characters of these three approach the Satsuma to such an extent that an untrained eye will be easily cheated into regarding them as the same. These oranges are shipped to Shanghai, and especially the first brings the highest price in the market. The Tsaokieh has been determined as a variety of *Citrus nobilis*<sup>(160)</sup>, but the tree, studied at different places, was not Tsaokieh and it was later learned that it was the true Kunembo, called Pentihuang (Local Yellow orange). This is most closely related to the Satsuma and there is a seedless form also, according to HU<sup>(41)</sup>. The other two are somewhat different from the Satsuma. Short descriptions of the former two were previously given by the writer<sup>(155)</sup>. Detailed descriptions of the three are given as below.

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\* The American Willow-leaf Mandarin was identified by the author to be this species.

\*\* "Mandarine" of the French, "Mandarino" of the Italian, which is sometimes called "Tangerine" by the British, but the American tangerine quoted in this paper is an entirely different thing (*Citrus tangerina* HORT.).

## THE PENTITSAO

*Citrus succosa* HORT. ex TANAKA in Mem. Tan. Cit. Exp. Stat. I, p. 30 (1927); in Stud. Citrol. I, no. 2, p. 31 (1927).

Tree about 6 m. high, bushy and ramose, branchlets crowded, medium thin and thornless. Leaves small, ovate to elongate-lozenge, about  $8 \times 3$  cm. including petiole about 8 mm. long; leaf base acuminate, narrow, apex acuminate and emarginate at the tip, margin indistinctly crenulate, veins not prominent, midrib only projecting to the lower surface; side veins subconspicuous, veinlets obscure, reticulate, texture thick, dark green, resembles that of Satsuma in dried specimen. Fruit depressed globose, never becoming barrel-shaped, apex very peculiarly depressed, very rough and with sharp radiating grooves and large open navel mark at the stylar point; base rounded, only shallowly depressed and sharply grooved, not projecting nor sinuate at the calyx; surface pitted rather roughly, but not so rough as Mankieh except at the fruit apex, oily like the Yatsushiro, polished, color orange (RIDGWAY Pl. III.), oil cell dots less distinct, almost like the Mankieh, size non-uniform, larger ones nearly uniformly depressed and the pit generally surrounded by a little raised ring, while smaller ones are dense, forming minute foveoli giving a crepe-like feeling to the touch, the pitting closer in the Mankieh. Calyx rather large, regularly 5-lobed, tube part (body) distinct, frequently changing into pink color, lobes acute, slightly roof-shaped at the apex, dots rather apart, readily forming pits; stem medium-sized, notched to the calyx (calyx far better developed than in Mankieh).

Section of fruit thin-skinned, rind uniformly thin, oil cells small, distinct, round ones predominate, intersected by bottle-shaped ones, the oil cell layer takes about  $\frac{1}{2}$  of the whole thickness of the rind, inner layer becomes free from the pulp ball. Central column rather small, usually hollow, with white pith, cottony, fiber strands fine, attached to the carpel ends. Segments often automatically separate, also becoming free from the rind, wall thin, white outside. Pulp deep-colored, meaty (juice not freely released when halved), vesiculation fine, somewhat

parallel, rather indistinct, very sweet and quality extremely good tasting, almost exactly like that of the Satsuma, no after-taste, rag left in the mouth slightly more, but decidedly sweeter than the Satsuma. Pulp vesicles more or less attached to wall, fusoid to lozenge-shaped, blunt-tipped, wedge shaped or sub-acute, soft, flexible, shriveling when bent, not difficult to separate from one another, deep-colored, opaque, general character of the vesicle quite similar to that of the Mankieh, but tasting better, apex more often blunt and the juice does not squirt from pressure, sometimes very long stalked. Seeds few, medium sized, whitish, apex faintly tinted, striation rather pronounced, apex finely wrinkled, surface even, smooth, not striated at base, not beaked, rather plump and somewhat compressed. Testa rather thick, tegmen rather deep-colored inside, beautifully rose at charaza part. Embryo green, single or a few in a seed.

Specimen: Collected at Huangyen in Chekiang, China, by WAN Yuan-mo and PAO So-chao, Dec., 1926 (colored figures in T. T. note 35 p. 56-57).

The dimensions of the fruit and fruit parts are as follows: Average of 6 fruits: Girth, 17.7 cm.; diameter,  $5.7 \times 5.4$  cm.; height, 4.2 cm., No. of segments, 9-10; rind 2.7-2.8 mm.; center  $10.5 \times 7$  mm.; No. of seeds, 7.

The color of the inner layer of the rind is more or less yellow and pink, but it is not reddish like Mankieh. The navel viewed from the inside is raised and contains large oil cells looking almost like pulp vesicles. The texture of the rind is very similar to the Satsuma and it often bears raised warts due to Citrus scab infection. The navel point is sometimes closed, and in some fruits the calyx end is more or less sinuous. The outside corner of the segments is generally not rounded in cross section, while it is rounded in the Satsuma.

This species is sparingly cultivated in Japan and Quelpart, and is rather widely distributed, though it is not commonly known. It is most abundantly seen in the Province of Tosa (Kôchi Prefecture), where it is called the Jimikan (Local orange), somewhat related to the original Chinese name. In counties Mitsugi and Toyoda in Hiroshima Prefecture,

it is also known under the name Shôji Mikan\*. The Kôjiro, of Ikiriki in Nagasaki Prefecture and the Ômikan of Aoë in Ôita Prefecture are also identified as the same. The Maru-mikan of Kagoshima Agricultural College and Nagasaki Agricultural Experiment Station are also the same. Kôda-mikan, named at Count TACHIBANA's Agricultural Experiment Station at Yanagawa in Fukuoka Prefecture, and Heso-mikan in one part of Tosa Province, are also identified with this. Compared with the Satsuma, the outline of the fruit is smaller, rind thinner and decidedly uniform in thickness, central column smaller, number of segments less variable (almost uniformly 9 and 10), and also the whole segments are often twisted in, the two side walls being curved in the same direction. The fruit is also sometimes compressed sidewise. Oil cells more closely spaced with a mixture of round and bottle-shaped ones. Pulp vesicles similar to the Satsuma but slightly larger and more often attached to the side wall of the segment.

Although the fruit very much resembles the Satsuma, the flower is much smaller, and it is therefore not one of the members of the Subsection *Euacrumen*, but belongs to *Microacrumen*<sup>(193)</sup> or the *Deliciosa* subgroup<sup>(155)</sup>.

### THE MANKIEH

*Citrus tardiferax* HORT. ex TANAKA in Mem. Tan. Cit. Exp. Stat. I, p. 30 (1927); in Stud. Citrol. I, no. 2, p. 24 (1927).

Tree about 6 m. high; branches rather dense. Branchlets inermis, fine, and dense. Leaves regularly elliptic, ends acute and apex emarginate, texture rather thin, midrib prominent on the lower surface, vein and veinlets very fine and inconspicuous, size 8 × 3 cm. including petiole about 7 mm. long. Petiole short, only slightly winged. Fruit medium sized, larger (when crop is small) among medium fruited mandarins, soft, light weight, depressed-globose to barrel-shaped, often with protruded base; apex deeply concave with long radial grooves which are not

\* See Hiroshima-ken Nôkwai. Nôji Chôsa (Agricultural Investigations) vol. 1. (*Citrus*) p. 17, fig. 12. Hiroshima, Agr. Soc., M. 35 (1902).

regular, as in Ponkan, in number and in distinctness, usually 6-8 grooves in number, sometimes indistinct, surface orange in color (RIDGWAY Pl. III), deeply foveolate, especially rough at the apex, undulate, often baggy; oil cell dots rather distinct, size rather uniform, irregularly distributed at both ends without much difference in number, concave, all forming pits, some large ones bordered by an elevated circular ring; stylar point closed or showing a navel, navel not large, if present. Calyx small, acutely 5-lobed, tube part almost undeveloped, appearing as though calyx lobes all formed sepals; lobes rather thick, triangular, simply notched to the stem, light colored, comparatively small, very acute, under lens, oil cell dots distributed all over as pustulate protrusions, glabrous.

Section of the fruit appears very similar to Satsuma, but the odor of the cut surface is different. Rind medium, almost uniform in thickness; oil cells large, long, close, without distinct border, crowded and heaped, often reaching to the inner surface of the rind; inner layer somewhat raggy, colored, without imbedded fibers; inside of rind distinctly rosy in color. Central column medium-sized, round, hollow, pith almost none, floccose, slightly colored; fiber strands free and stand at the center, or are attached to carpel ends, more or less colored, with floccose pith around. Segments few in number, large, almost regular, outer end parallel with the surface of the rind, corner rounded, inner end broadly rounded, and has room at both sides. Wall thin, separable with ease although appearing adherent in cross-section, slightly more difficult to separate segments than in Satsuma. Pulp deep colored, orange (RIDGWAY Pl. III), almost like the Satsuma, vesiculation rather coarse, elongate-reticulate, more or less gathered at the mid-line, indistinct, very meaty, sweet, soft, palatable, good quality; when over-ripe, taste is somewhat musky. Pulp vesicles soft, separable, more or less attached to the side wall but not conspicuously, very tenacious, flexible, shriveling when bent, meaty, breaking at the tip with pressure without the juice squirting out, generally fusoid in outline, pointed or obtuse, orange-colored, opaque, usually short-stalked. Seeds many, somewhat like melon-seeds, compressed, apex rounded or simply pointed, base pointed or slightly beaked;



testa thin, tegmen light-colored, more yellowish, charaza part light-colored, mono-embryo light-colored.

Specimens: Purchased at Tai chou Hai mon, Chekiang, China; also from orchards of Mr. WAN and Mr. PAO. Dec., 1926.

Measurement of the fruit and fruit parts is as follows: Average of 6 fruits: Girth, 20.7 cm.; diameter,  $6.6 \times 6.3$  cm.; height, 5.3 cm.; No. of segments, 8-9; rind, 2.4-3.1 mm.; center,  $15 \times 13$  mm.; No. of seeds, 61.

The cross section of the fruit is particularly like Satsuma; the texture and quality of pulp, the texture and the surface of the rind are alike, but in Satsuma the oil cells never reach the inner surface of the rind, while they do in Mankieh. The flatness of the seed is not so conspicuous as in Pentitsao, but it is quite different from that of Satsuma. A close comparison of Mankieh with Satsuma is tabulated below:

(1) Points of similarity to the Satsuma:

1. The size and the color of the fruit.
2. Texture of the rind, (slightly more yellow inside, in Mankieh.)
3. Inner end of the segment and the character of the central column.
4. Color and quality of pulp.

(2) Points of difference from Satsuma:

1. Calyx is entirely different, which shows diversity in the floral characters.
2. Presence of basal mamilla and sharp grooves.
3. Fruit flatter in Satsuma and smoother.
4. Oil cell dots larger and more uniform in Satsuma and distinctly less pitted. In Mankieh, dots are larger and making deeper pits.
5. Apical grooves are much more distinct in Mankieh.
6. Segments more numerous and smaller in Satsuma: Outer end of segment wall is less swollen in Mankieh, and corner is less rounded.
7. Pulp vesicles much larger in Mankieh.
8. Oil cells in cross-section of the rind are more uniform in Satsuma. In Mankieh, large ones predominate and extend to the inner surface of the rind.

9. Pulp vesicles are slightly more assembled toward the center in Satuma.

10. Pith of the central column is more floccose in Satuma. In Mankieh, it is more compact around the fiber strands; the color of pith is whiter in Satuma.

In comparison with Yatsushiro, the odor of the cross-section of the fruit is similar, the pulp is also similar and the taste is very much alike. The seed of Mankieh is, however, much smaller, less yellow in color and never elongate-beaked. Some small seeds of Yatsushiro look very similar to those of Mankieh. The color of the embryo is different: Yatsushiro being lighter and more bluish. The oily rind surface of the fruit is similar, but the color of the pulp is brighter in Mankieh. The texture of the pulp is alike.

The Mankieh does not exist in Japan, and the name is not found in any literature. Its relation with the true Wen Chou orange (*Citrus suavisissima* HORT.) has been discussed elsewhere, and a good photograph was given in a former publication<sup>(1,2)</sup>. The living plant was introduced by the writer into Japan in 1925, with other Citrus fruits.

## THE TSAOKIEH

*Citrus subcompressa* HORT. nov.

= *Citrus nobilis subcompressa* HORT. ex TANAKA in Stud. Citrol. I, no. 2, p. 36 (1927).

Vegetative part not seen. Fruit depressed globose, outline very similar to the Satuma; color orange (RIDGWAY Pl. III); oil cell dots small, rather dispersed, forming foveoli with needle-point pits, of irregular size but not uniformly distributed, the sorting being at random; fruit apex depressed rather deeply but without radiating grooves, navel open but small; base sinuate and furrowed, leaving irregular ridges between. Calyx small, rudimentary, surrounded by circular ring.

Section of the fruit spicy in odor: Rind thin, oil cells large, close, nearly occupying the whole area of the rind, the layer being more than 2/3 of the total thickness, bottle-shaped, elongate, inner layer yellow,

shallow. Central column rather large and hollow ; pith white, like felt of mycelium of fungi, closely attached to the segment, never raggy or pithy ; fiber strands large, causing two or three segment ends to adhere together, embedded in thick pith of somewhat pinkish color. Pulp ball easily separable from the rind but the rind is not baggy. Segments many, more or less regular, outer end more or less rounded, corner somewhat rounded, inner end mamillate, side wall somewhat adherent near the inner end. Pulp meaty, not so juicy as *Pentitsao*, coarsely grained, vesiculation coarsely reticulate, indistinct, color nearly orange (RIDGWAY Pl. III), flavor not very pronounced, sweet, no acid, aromatic, rather insipid (being over-ripe when studied), rag remaining in mouth primarily due to the existence of hard part at the inner end of segment wall. Pulp vesicles rather large, inside ones fusoid, acute, tapering or curved, outside ones plump, obtuse, strongly attached to side wall of the segment, all separable, soft, meaty, juice not squirting under pressure, opaque, orange colored. Seeds many, plump, apex rather rounded, base beaked, white, with little or no striation but raphe-line clear and sunken spots present ; testa thin, tegmen light or more or less sooty colored, not brownish, charaza part rosy, not purplish, embryo green, secondary ones deeper in color.

Specimens : Purchased at Hungho Grocery in Shanghai, China, later identified by picture as *Tsaokieh* by Mr. WAN Yuan-mo of Huang-yen, Chekiang, China.

Measurement of the fruit is as follows : Girth, 20.6 cm. ; diameter, 6.6 × 6.4 cm. ; height, 4.5 cm. ; No. of segments, 12 ; rind, 2.5–3 mm. ; central column, 17 × 16 mm. ; No. of seeds, 19.

The fruit of *Tsaokieh* resembles that of *Kunembo* in general characters of pulp vesicles, color of tegmen, oil cells, etc. This has a considerably thinner skin, hollow center, and quite meaty, better flavored pulp. The arrangement of pulp vesicles is very coarsely reticulate, much more pronounced than *Kunembo*. Although there is a thin-rind form of true *Citrus nobilis*, studied at Singapore in 1923, the relation between these two and the *Suhoi* mandarin of Canton is not clear. The present species has no characteristic seed attachment like *Kunembo*, from

which it is distinct on that account. This species is not known in Japan or in other places of China. The author introduced a plant, called Tsaokieh, from Huang-yen where the type material was produced. It is, however, uncertain whether this plant really represents the true Tsaokieh or Pentihuang, the true *Citrus nobilis*. Grafted plants of this material were introduced by the writer into the United States together with the first two. The C. P. B. numbers of these are 10480 (plant introduced by T. T. from China under the name Tsaokieh), 10483 (Pentitsao), and 10484 (Mankieh).

### THE TRUE WEN CHOU ORANGE

Despite the richness of the races of Citrus fruits which were recorded from Wen Chou in the twelfth century, very little is known about the actual situation of these races at the present time. CARLI<sup>(18)</sup> mentioned only the existence of a sour orange (arancio amaro) in Wen Chou, and HENRY collected a specimen of this under the name Chih ko. A recent survey of HU<sup>(12)</sup> threw a new light upon the diversity of forms now under actual cultivation at Wen Chou and its vicinity. According to his reports, the following species of Citrus fruits occur in this region. His method of investigation, thoroughly based upon the writer's scheme, was so successful that almost no correction of the specific name is necessary. The new change of names, whenever it became inevitable, is marked with asterisks.

- |                                    |   |
|------------------------------------|---|
| 1. Chih ch'üeh (of book)           | <i>Poncirus trifoliata</i> RAF.           |
| 2. Hsiang yüan: Kou yüan (of book) | <i>Citrus medica</i> LINN.                |
| 3. Yu (of book)—6 varieties.       | <i>Citrus grandis</i> OSBECK.             |
| 4. Chu luan: Suan ch'ên (of book)  | <i>Citrus Aurantium</i> LINN.             |
| 5. Kuan chü: T'ien ch'ên (of book) | <i>Citrus sinensis</i> OSBECK.            |
| 6. Kan: Ou kan (of book)           | <i>Citrus suavisima</i> HORT. ex TANAKA.* |
| 7. Chang chü: Hung chü (of book)   | <i>Citrus tangerina</i> HORT. ex TANAKA.* |
| 8. Chu chü                         | <i>Citrus erythrosa</i> HORT. ex TANAKA.* |
| 9. Pen ti chü                      | <i>Citrus kinokuni</i> HORT. ex TANAKA.*  |
| 10. Kuang chü                      | unidentified small mandarin.              |
| 11. Chin chü                       | <i>Citrus microcarpa</i> BUNGE.*          |
| 12. Lo fu                          | <i>Fortunella margarita</i> SWINGLE.      |
| 13. Chin tan                       | <i>Fortunella crassifolia</i> SWINGLE.    |
| 14. Yüeh yüeh chü                  | <i>Fortunella obovata</i> TANAKA.         |

Ilu states that the Kan (Ou kan, or the orange of Wen Chou) is the most important product among the Citrus fruits and is exported to Dairen, Tientsin, Shanghai, etc. Through the courtesy of Mr. Uhachi TAKIZAWA, of Wen Chou, the writer was able to secure abundant material of this celebrated orange of Wen Chou, and he described it with an illustration<sup>(152)</sup>. The description is given below :

*Citrus suavissima* HORT. ex TANAKA in Stud. Citrol. I, no. 2, p. 38 (1927).

Tree. Leaves medium sized, broad, coarsely crenulate at the upper part, texture rather thin, only midrib being prominent, veins and veinlets being indistinct. Petiole winged, wing rather conspicuous, obovate-oblongate, rounded at the apex, reaching to the base of petiole. Fruit obconical to tall depressed-globose,  $75 \times 60$  mm., soft, orange in color, rough, much depressed at ends, grooves at the apex irregular, those at the base conspicuous; oil cell dots always concave, small, of uneven size, surface of rind oily and later becomes minutely shriveled due to the softness of texture. Calyx small, lobes not well developed, slightly swollen, glabrous. Section of the fruit faintly scented, rind thick, 5-6 mm., oil cells very large and dense, bottle-shaped or obovate, heaped in layers, inner part of the rind soft, white but tinted very light orange color. Segments few in number, 8-11, rarely 14, average about 10, outer end of segments rounded, inner ends also rounded; central column small, diameter about 15 mm., wall thin but somewhat closely adherent and distinctly bitter in taste, surface pure white and silky, pith of the central column arachnoid, small in quantity. Pulp orange (RIDGWAY Pl. III.), soft, meaty, agreeably mixed with sweet and acid flavor, refreshing, good quality, most palatable. Pulp vesicles coarsely reticulate, many attached to side wall of segment, more or less coarse grained, polygonal, fusoid, opaque, shriveling when bent, easily broken, freely separated; stalk short and strong. Seeds rather small, generally few in number varying from 6 to 23, more or less plump, not flattened, pointed at ends but not beaked, faintly striated, slightly tinted at the apex, surface yellowish; testa thin, tegmen light-colored, charaza portion purplish, polyembryo pale-colored.

Specimens : 20 fruits sent from Wen Chou fu by U. TAKIZAWA.  
Seedling at Miyazaki Agricultural College ground.

It resembles Mankieh in the outline of the fruit, but the petiole is winged, and the leaf base not attenuate, as sometimes with Mankieh leaf. The rind, pulp, and seeds are all different. The appearance is also somewhat similar to the Japanese Iyo-mikan, but the character of pulp and seed is entirely unlike. Compared with the Satsuma, the leaves are smaller, thinner, veins less prominent, and petiole wing distinct. The fruit also differs in rind character, pulp, and pulp vesicles. The seeds are somewhat alike, but the color of the tegmen is not similar. Since no orange is known identical to this, it was described as a horticultural species.

The description clearly shows that this has no relationship with the Satsuma. If this is the kind which has predominated in Wen Chou for many hundreds of years, it can be seen easily that the origin of the Satsuma is in no way connected with this orange. If the true Satsuma was in existence in ancient days, there is no reason why it should now be absolutely exterminated. It is more conceivable that the Satsuma has never existed in Wen Chou, or in any part of China.

It seems probable that the true Wen Chou orange is not cultivated elsewhere in China. It is a very delicate orange, the rind being attacked by mold, causing it to decay quickly. It appears in Shanghai and Peiping markets only for a very short time, and it is sold at a very high price, not only because of its very refreshing quality but from its short appearance in the market. The peculiar, bitter taste of the segment wall soothes the tongue of opium smokers, and it is therefore much consumed by them. Fruits of the same kind were once purchased by the writer in Canton under the name of Chao Chou kam, but the true Chao Chou kam is the Ponkan, entirely different from this species.

## SYSTEMATIC POSITION OF THE SATSUMA ORANGE

Most horticultural works treat the Satsuma as a variety belonging to

the mandarin group\*. The so-called mandarin in America is an aggregate species, including King, Dancy, Oneco, Cleopatra, Willow-leaf, Clémentine, Satsuma, etc. etc. It may include "tangerines" of the red skinned members, like Dancy and Cleopatra. SWINGLE<sup>(127)</sup> first defined mandarin as belonging to *Citrus deliciosa* TENORE, making it a variety of *Citrus nobilis* LOUR., having as a type the King orange of Florida. He states, however, that "it is still a matter of doubt whether the mandarin orange is merely a variety of *Citrus nobilis* LOUR. or a distinct species, as there are a number of other rather diverse varieties such as the 'tachibana', a wild, sour form from Liukiu Island, and the Tangerine, a red-fruited, large-leaved form probably of Chinese origin, now widely grown in warm climates." Later study shows, however, that the difference between Tachibana, or Shiikuwashâ, the wild Luchu orange\*\*, and the Satsuma is greater than the difference between lemon and citron, or sour and sweet oranges. The fruit of the Satsuma is three times as large as that of the Tachibana, leaves and flowers are almost twice as large, color and texture of rind, number of segments, shape and contents of pulp vesicles in no way correspond one with the other. The only common point is the solitary flower, the easily peeled rind, and the greenish polyembryo. But sour and sweet oranges have a number of characters in common—small-panicled inflorescence, tight peel, whitish polyembryo, etc. The similarity between the leaf characters of sour and sweet oranges is far greater than that between the Satsuma and the Tachibana. If sour and sweet oranges belong to different species, why should not the Tachibana and the Satsuma? The Mediterranean mandarin, similar to the type tree now still surviving in the Botanic Garden in Naples, is entirely different from both Tachibana and

\* See HUME, H. H. *Citrus fruits and their culture*. 1904, p. 110-112; also COIT, J. R. *Citrus fruits*. 1915. p. 79; etc.

\*\* Tachibana does not occur in Luchu, but Shiikuwashâ (*Citrus depressa* HAYATA) is very common there. See TANAKA<sup>(155)(161)</sup> and Nippon Ryôdo no yasei Kankitsu ni tsukite (Wild Citri of the Japanese territories) in Kyôshû Teikoku Daigaku Nôgakubu Gakugei Zasshi (Bult. Sci. Fak. Terk. Kju. Imp. Univ.) vol. 2, no. 1, p. 51-58. 1925, and Ryûkyû Okinawa no Shiikuwashâ (On Shiikuwashâ orange in Okinawa, Ryûkyû) in Shokubutsu Kenkyû Zasshi (Journ. Jap. Bot.) vol. 3, no. 8, p. 190-193, illus., Tokyo, 1926.

Satsuma. Its bushy branches, narrow leaves (willow-like), depressed oily fruit with very regular radial grooves from calyx end, etc., are very definite characters, resembling no Chinese orange growing on the southern coast. Perhaps Kôji mandarin (*Citrus leiocarpa* HORT.) is similar in fruit characters, but the shape of the leaf and the size and minute characters of the flower and the fruit are very different. The Kinokuni mandarin also to a certain extent resembles it, but the diversity is too great to unite them into one species. The Mediterranean mandarin is likewise distinct from the King orange, which differs also widely from the Satsuma or the Tachibana. As is thoroughly discussed in another place<sup>(12)</sup>, the author came to the conclusion that the mandarin oranges are a group of many distinct species. Hasty determination of previous authors, putting them into a model species, is due to the lack of close carpological and anthological investigations, or otherwise is based upon a prejudice that the species is merely a vague group of diverse forms difficult to distinguish. The writer maintains that the species is a definite group of uniform members, and whatever may be the difficulty, the distinction of such groups can be made secure through attentive morphological investigations. It is unbelievable that whole groups have sprung up from the same root-form typified by a certain name, such as *Citrus nobilis* AUCT. Such a conception, placing all diverse, widely ranged, distinctly heritable members of *Citrus* as subordinate to a purely imagined, conventional, cultivated type figure, like *Citrus nobilis* AUCT., is strongly against the present theory of botanical taxonomy—that each species must be represented by a definite type individual. *Citrus nobilis* of LOUREIRO has its own typical figure, not to be disturbed by the aggregation of subsequent forms, not related morphologically, historically, and geographically. It is thoroughly logical to split *Citrus nobilis* AUCT. into distinct species, represented by non-gradating morphological characters and by historical and geographical independence. It is therefore proposed by the writer<sup>(155)</sup> that the entire loose-skin orange group (Sect. *Acrumen* TANAKA) be divided as follows :

(1) Nobilis subgroup (Subsec. *Euacrumen* TANAKA).....Trees of few branches. Leaves large and thick, veins prominent, petiole wing often



distinct. Flower large, petals reflexed. Fruit comparatively large and oblate, ends concave, with no regular radial grooves. Calyx large.—*Citrus nobilis* LOUR., type, (King orange); *Citrus unshiu* MARC. (Satsuma); *Citrus yatsushiro* HORT. (Yatsushiro); etc.

(2) *Deliciosa* subgroup (Subsec. *Microacrumen* TANAKA)..... Shrub of many branches. Leaves small and thin, veins not prominent, petiole wing only fringed. Flower small, petals not strongly reflexed. Fruit small to medium-large, oblate or round, often projected at the base, frequently with regular radial grooves. Calyx small. *Citrus deliciosa* TEN., type (Mediterranean mandarin).

(A) Large fruiting species.....*Citrus deliciosa* TEN.; *Citrus poonensis* HORT. (Ponkan); *Citrus genshokan* HORT. (Genshōkan); *Citrus tangerina* HORT. (Ankan, Dancy, Aka-mikan); *Citrus erythrosa* HORT. (Chushakan, Kobeni-mikan); *Citrus succosa* HORT. (Pentitsao, Jimikan); *Citrus tardifera* HORT. (Mankieh); etc.

(B) Small fruiting species.....*Citrus kinokuni* HORT. (Kinokuni); *Citrus ponki* HORT. (Ponki); *Citrus depressa* HAYATA (Siikuwashā); *Citrus leiocarpa* HORT. (Kōji); *Citrus tachibana* TANAKA (Tachibana); etc.

(3) *Microcarpa* subgroup (Subsec. *Pseudofortunella* TANAKA)..... Shrub of many branches. Leaves small, reverse side pale colored, veins quite inconspicuous. Petiole wing linear. Flower small. Fruit small, ends flat, smooth, with distinct kumquat aroma.—*Citrus microcarpa* BUNGE, Type (Tō-kinkan, Calamondin).

From this clear presentation of all the important members of the so-called *Citrus nobilis* AUCT., it can readily be seen that the Satsuma differs greatly from the subgroup of the Mediterranean mandarin (*Microacrumen*). The size and nature of the leaf and the flower of the Satsuma are nearer to the Sour-Sweet Orange group (Sect. *Aurantium* TANAKA), but the fruit is entirely different. The reason why such a loose-skin orange group (Sect. *Acrumen*) is to be established lies primarily in the occurrence of solitary or fascicled flowers not forming any inflorescence on an elongated common peduncle. The greenish embryo and free peeling are rather subordinate secondary characters. All primitive forms of

Citrus relatives have definite inflorescences, like *Micromelum*, *Glycosmis*, *Clausena*, *Chalcas*, nearly all hard-shell groups, together with *Hesperethusa*, *Citropsis*, *Atalantia*, etc. Those which have solitary or fascicular flowers are more advanced (or retrogressive, if shortening of the peduncle is not to be called progressive) members, such as *Severinia* (vs. *Atalantia*), *Paramignya* and *Wenzelia* (vs. *Lavanga* and *Pleiospermium*), *Microcitrus* and *Eremocitrus* (vs. *Oxanthera*), and so on. As is presented in other publications<sup>(184)(140)(191)(185)</sup>, *Citrus* is unquestionably derived from pinnate members, *Citropsis* coming very close to it, possibly having *Hesperethusa* and *Clausena* as remote ancestors. Differentiated inflorescence is carried down in large winged members of *Citrus*, for instance, Shaddock (*Citrus grandis* OSBECK), Cabuyao (*Citrus macroptera* MONT.), *Citrus latipes* TANAKA, and sour orange (*Citrus Aurantium* LINN.) Acid fruiting, tight-skin oranges all have paniculate flowers, and reduction in the flower peduncle; and free separation of carpels have developed later. This secondary development brought into existence the Yuzu-ichangensis group (Sect. *Osmocitrus* TANAKA) and loose-skin orange group (Sect. *Acrumen*), and probably later kumquats (genus *Fortunella* SWINGLE). Among loose-skin oranges, unquestionably some small fruiting members of the *Deliciosa* subgroup developed first, which gave way to further progress into large fruiting members, and finally to the *Nobilis* subgroup. The Satsuma is possibly a super-bred type (Hochzucht) of the whole loose-skin group, as is the sweet orange among members including sour orange, *Citrus taiwanica*, Ambul dodan (of Ceylon), etc.

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## **BOOK III**



## POMOLOGICAL STUDIES IN THE SATSUMA ORANGE

### DEVELOPMENT OF VARIETIES IN THE SATSUMA ORANGE

It is evident that almost all fruit trees brought under cultivation for a long time develop differences in character with response to their cultural conditions or environment. Early ripening varieties, late maturing varieties, large-fruited varieties, and so on, are not infrequently met with in practical fruit culture, and the isolation of such varieties is generally regarded as an important step in developing an industry. This is also the case with the Satsuma orange. The development of the Satsuma orange culture in recent years is chiefly the result of the distribution of better varieties, as will be noted later. Future progress evidently is dependent primarily on the discovery and the adoption of new and profitable varieties.

Before taking up the history of the variety segregation of the Satsuma orange, a brief review of variety studies must be outlined. It was first known to the writer as early as 1912, that such varietal differences existed within the species<sup>(139)</sup>. He enumerated the variety names, without description, such as Zairai, Owari, Ikeda, Wase, Hira, Kiku (corrugated), Fuiiri (variegated), and Hime (small-fruited). HIRANO<sup>(40)</sup> then described three different varieties, Ikeda, Owari, and Wase, based upon the examination of the morphological characters of living material. KADOOKA<sup>(41)</sup> later applied the statistical method to distinguish two varieties prevailing in Nagasaki Prefecture. The variety distinction based upon the writer's own observation in the years between 1908 and 1915 was then published<sup>(140)</sup>. Standardization of varieties actually grown in Alabama and adjacent states was inaugurated through the effort of the Office of Crop Physiology and Breeding Investigations, and the Pomological and Horticultural Investigations of the U. S. Department of Agriculture, with the cooperation of the State horticultural authorities.

The result was published in subsequent papers of SCOTT<sup>(162)(168)</sup>. This movement was acknowledged to be fruitful in the development of the Satsuma industry in the Gulf States, and MIKI<sup>(71)</sup>, TOGASHI<sup>(213)</sup> and TAKAHASHI<sup>(133)</sup> reported that similar efforts were also necessary in Japan. The author continued his work in Japan until 1922, identifying all important varieties growing there and using a new pomological method based upon morphological and statistical investigations. This work brought about the discovery of different strains of the Wase variety originated through bud variation<sup>(169)(170)</sup>. He then concentrated on the discovery of still more strains of the Wase Satsuma, and in subsequent papers brought to light the facts about, and the significance of, these variety investigations<sup>(172)(173)(175)</sup>.

## SIGNIFICANCE AND LIMIT OF THE TERMS VARIETY AND STRAIN

Before taking up the problem of the varieties and strains of the Satsuma orange, it will be worth while to discuss the terminology of "variety" and "strain". Any form which is different from the type of the species by an accidental cause is termed "variety" by LINNAEUS\*. This should hold good for both botanical and horticultural varieties, or the *indivar* and the *cultivar* of BAILEY<sup>(10)</sup>. There is no essential difference between botanical and horticultural varieties, except that the latter is of garden origin, and is disseminated either by sexual or only by vegetative propagation. The distinction of variety from the type species is only through morphological differences in character, whatever be the origin of such divergent characters. Hybridization, if the evidence of crossing is traceable, is one means of bringing forth such a new variety, but there may be other causes, such as somatic or sexual character segregation through change in the allelomorphic combination, sexual or somatic mutations through allelomorphic transformation, or the change of chromosome numbers, or

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\* *Philosophia Botanica*, 1751, p. 100.

a chimeric formation of tissue. Any new form of permanent nature when it is "heritable" or, in other words, when it is perpetuated by any method of propagation, we can regard as a variety, if the qualitative difference from the type is sufficiently great. It is a good botanical variety, no matter how "impure" in nature, or technically speaking, whatever it may throw out as heterogenous offsprings and whatever different gametic constitutions such offsprings have. If such a form is entirely different from the type, viewed in all possibilities of morphological evidence, we may regard this as beyond the boundary of the original species, and call it a different species. Such species, differing from other species in essential characters of a qualitative nature, are divided likewise into two groups, wild and horticultural, or *indigen* and *cultigen* according to BAILEY. Any horticultural species is exactly like a wild species in its bearing and limits, but is of garden origin, and may be disseminated only through vegetative propagation if it fails to breed true by other means of reproduction. Following the idea of LINNAEUS, established in his *Philosophia Botanica*<sup>(56)</sup>, we need not consider the divergencies of the offsprings of the species, if the specific characters are carried down without any loss by certain numbers of the descendants. Likewise, it is a matter of indifference whatever the plant grows only in the garden or in the jungle, and in what method the plant is propagated. Therefore, we are convinced that the handling of any species and variety in botanical and horticultural nomenclature must be similar. Hybrids, of species and variety rank, may receive a different treatment, but they can as well be handled like natural forms. The important point in defining species and variety lies not in the origin, different behavior in genetical viewpoint, nor in the stability or uniformity of the offsprings, but principally in the character-differences of a purely morphological nature. Only the weight of character-differences determines the rank. A species is the unit of an organism and its boundary is definite: a variety represents minor differences and its boundary is not so definite. The Satsuma, for instance, is not a Kunembo, nor a Yatsushiro: the distinctions are very clear and definite. Satsuma varieties are Satsumas, the difference being only of interest to the horti-



culturists. Botanically, such variety distinctions may be unnecessary; economically they are of utmost importance. As they are worth naming, standard names are necessary to stabilize the industry. This situation always should be borne in mind in treating the variety question in the Satsuma orange.

In modern horticulture, another term of distinguishing individuals or a group of individuals has been introduced in the name "strains". SHAMEL and others<sup>(110)</sup> define the strain as "a group of individuals of a horticultural variety which differs from all other individuals of the variety in one or more constant and recognizable characteristics capable of perpetuation through vegetative propagation". It is understood from this definition that the strains are distinguished within a commercial variety by differences when compared with all the other members which all together form the variety. To take an example, the Washington Navel orange is a commercial variety of the sweet orange (*Citrus sinensis* OSBECK) and Washington, Australian, Thomson, Golden Nugget, etc., etc., are the strains of this variety. The chief difference in the horticultural conception of a strain from the conception of species and variety above mentioned is the lack of recognition of a type. Any species must be represented by a type\*. The variety finds its standing only relative to the type species, but the type concept is still maintained even in the case of a horticultural variety\*\*. A species is not an aggregate group of different varieties, but is a definite figure represented by a type specimen from which the original diagnosis or description was drawn. A variety is a different form of the type of the species, the distinction of which is relative to the species, but not to the other varieties. The variety is

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\* See COOK, O. F. The method of types in botanical nomenclature, in *Science*, n. s. vol. 12, no. 300, p. 475-481, 1900; and SWINGLE, W. T. Types of species in botanical taxonomy, in *Science*, n. s. vol. 37, no. 962, p. 864-867, 1913.

\*\* See ROBINSON, T. R. Correct horticultural names of Citrus fruits. in *Citrus Indus.* vol. 10, no. 10, p. 4-5, 23-29, 1929. "Code of Fruit Nomenclature" adopted by the American Pomological Society on Nov. 8, 1924, gives the following rule: "16. The type of a variety is the fruit of the original plant; and type descriptions or illustrations shall be made from material produced by the available, from a plant as near as original plant, or when this is not possible to the original in a sexual reproduction, and preferably grown in the same pomological region."

established when such a different form is detected and isolated from the type of the species. The strain, according to the definition given before, exists only relative to "all other individuals", not relative to the type of the variety. This means that the strain is a group of individuals chosen from the rest of the individuals, all together forming a variety. This sounds clear and practicable, but really it is impossible to compare certain individual plants to all the other individual plants of the variety now in existence. The need of a type of such a variety is imperative to make comparison practicable. The Washington Navel orange, for instance, needs to have its type, or a representative figure, more clear than only what it means to innumerable individuals or groups of individuals. If the type of the variety "Washington Navel" is clear, we can easily distinguish any number of different groups of individuals from it. We do not know whether the Washington Strain really represents the type of the variety or not, but in case it does not, the repetition of the name which appears in the higher rank is destined to be proscribed. At any rate, the definition of the strain must be modified to designate "a group of individuals essentially different from the type of the variety, and such difference must be smaller than distinguishing the variety from the type of the species". When the variety is distinguished through minor differences, the strain must be separated by still smaller differences, possibly quantitative in nature. Varieties and strains are based merely upon the magnitude of differences in character, and the distinction of strains always comes after the distinction of varieties. The above given discussions cover the case when the difference in strain exists within the botanical variety, but such a difference may exist within the species. Proper modification of the above given definition of a strain is understood to be necessary, if such a difference is isolated from the species. The "Botanical Code of Nomenclature"\* gives the word "forms" (les formes) to designate strains, and demands the designation of such forms "in common language, as different as possible from the latin names of

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\* See Règles internationales de la nomenclature botanique. Jena, G. FISCHER, 1912, Article 30.

the species or varieties." The "Rules of Horticultural Nomenclature" mentions the word "horticultural varieties of species and simple forms" and admits the use of Latin adjectives to name them\*. Monstrosities are not to be named botanically\*\*, but no rules restrict their being named in the vulgar tongue. Speaking of examples, the following names are permitted: *Citrus sinensis* Person Brown (or *Citrus sinensis* OSBECK 'Person Brown'); *Citrus sinensis brasiliensis* Corrugated (or *Citrus sinensis* OSBECK var. *brasiliensis* TANAKA 'Corrugated'). Here we regard that the Washington Navel orange is neither a simple form nor a monstrosity of the sweet orange, but is a good botanical variety distinguished from the type of the species by many distinct essential characters<sup>(185)</sup>\*\*\*. Corrugation of fruit is rather a monstrous character, and may not stand valid as "*forma corrugata*". There are, however, many names similar in nature, such as "*variegata*", "*canaliculata*", "*corniculata*" and so on, adopted in old monographs of Citrus fruits, and they stand as forms or even as varieties. In the case of the Washington Navel orange, there are similar variations of a monstrous nature which can be propagated<sup>(19)(115)</sup>. Such form may arise from the Washington strain or from the Thomson strain. If some of them came from a certain definite strain of the Washington Navel orange, they belong to that particular strain and cannot be called an independent strain. We may call it a "substrain". If the original strain from which abnormalities have arisen is definitely known, the name of such a subsrain must bear also the name of the strain as "Yellow Washington", "Yellow Thomson", "Pear-shape Washington", "Pear-shape Thomson", etc. etc. Such naming may be necessary, because any standard strain has a possibility of producing substraains of a similar nature. Careful grouping of strains and substraains will help to segregate undesirable variations occurring in the commercial varieties of Citrus fruits.

\* See Horticultural nomenclature, in Journ. Roy. Hort. Soc. vol. 23, p. 140-151, 1911. Article II, on p. 149."

\*\* See above given Règles, Article 51, 3°.

\*\*\*The use of a Latin proper name in the horticultural varieties which designates the origin of the varieties, is permitted in the new code of Horticultural Nomenclature adopted at the London Congress, 1930. See Gard. Chron. III. 83. (2278) : 156. 1930.

## PRELIMINARY STUDIES IN SATSUMA VARIETIES

From the years 1909 to 1911, the author examined Satsuma fruits only occasionally, either on visits to producing localities, or through material sent by request, acquired at exhibitions, or bought in the market. The primary conclusion from these observations was: three great nursery districts, Owari, Ikeda, and Tanushimaru, have their independent origin of development based upon their own local variety, and the localities which have developed their own industry without receiving plants from these professional nurseries have likewise developed their own variety.

The oldest known nursery district, Ikeda, supplied plants to the growers of Wakayama and Ōsaka, and these plants are mostly much dwarfed, the leaves being smaller, crowded, and having acute-angled tips. The fruits from these plants are small, round, thick-skinned, and can be kept very long under ordinary storage. For three years, the writer was engaged in hybridization work in his own orchard at Maitani, near Ikeda, Hyōgo-ken, where trees of this variety had been planted under uniform conditions, the fruit from which was all carefully studied statistically. The measurement of 17 fruits obtained in 1911 after uniform treatment is as seen in Table 2. The diameter-height index in this lot is only 1.17, meaning that the fruit is nearly round.

In the same year, three other fruits were obtained from Minoo, near Ikeda; their fruit diameters were 5.6; 6.0; and 6.1 cm., and the D/H index were 1.14, 1.26, and 1.38, respectively. Four fruits were also obtained from Wakayama, and they measured as follows: diameters, 6.7, 5.15, 5.45, and 5.5 cm.; D/H index 1.36, 1.32, 1.30, and 1.30, respectively. Two other items of the same variety were also studied during the period of 1909-1911. The result of the measurements was brought together in Table 3.

Another lot of Satsuma fruits borne on plants originally distributed by the nurseries of Owari Province was studied during the same period. These fruits were larger and flatter in comparison with the fruits of Ikeda. All fruits submitted to the author's examination during this period are shown in Table 4.

TABLE 2.

MEASUREMENT OF 17 FRUITS BORNE ON UNIFORM TREES IN TANAKA'S  
ORCHARD AT MAITANI, NEAR IKEDA, JAPAN (IKEDA VARIETY)

Fruit No.	Girth	Diameter	Aver. diam.	Height	D/H index	No. of segm'ts
1	19.8cm.	6.15 × 6.05cm.	6.10cm.	5.30cm.	1.17	10
2	18.8	6.00 × 5.70	5.85	4.85	1.21	10
5.1	18.6	5.90 × 5.70	5.80	4.80	1.21	11
5.2	17.6	5.55 × 5.35	5.45	4.75	1.15	10
9	20.3	6.50 × 6.25	5.38	5.20	1.03	10
10	16.3	5.20 × 4.95	5.08	4.35	1.17	10
11	17.9	5.60 × 5.60	5.60	4.90	1.14	10
14	17.8	5.60 × 5.50	5.55	4.60	1.20	11
18	18.3	5.80 × 5.70	5.75	4.40	1.30	11
20	16.2	5.20 × 5.00	5.10	4.40	1.16	10
25	23.5	7.55 × 7.20	7.38	6.30	1.17	10
27	18.0	5.80 × 5.55	5.68	4.70	1.20	10
34.1	15.5	4.90 × 4.70	4.80	4.10	1.17	9
34.2	15.6	4.90 × 4.70	4.80	4.10	1.17	10
34.3	16.6	5.10 × 5.10	5.10	4.30	1.19	10
104	15.7	4.80 × 4.80	4.80	4.30	1.12	9
105	17.8	5.60 × 5.40	5.50	4.55	1.21	10
average	17.9	5.66 × 5.48	5.51	4.70	1.17	ca 10

TABLE 3.

MEASUREMENT OF SATSUMA FRUITS REPRESENTING IKEDA VARIETY  
DURING 1909-1911

Locality	No. of fruits	Av. diam.	D/H index
Minoo, Kawabe-gun, Hyōgo-ken	3	5.90cm.	1.26
Wakayama-ken	4	5.45	1.32
Arita-gun, Wakayama-ken	5	5.91	1.23
Tosa, Shikoku Island (TAMURA's "Suzunari" strain)	5	5.50	1.33
Altogether (and average)	17	5.69	1.29

These fruits, originally from the Owari nurseries, have large leaves, not very numerous, and many of them are pendant with a broad basal end. Fruits are large, flat, generally soft and not keeping well in storage. Storage of the Satsuma has been developed in Ôsaka Prefecture, where trees of the Ikeda nurseries predominated, and developed only very recently in Shidzuoka and Kanagawa Prefectures, where trees of the Owari nurseries are cultivated almost exclusively. The fruit very often develops a large navel marking, and year-old nursery plants frequently develop thorns.

TABLE 4.  
MEASUREMENT OF SATSUMA FRUITS REPRESENTING OWARI VARIETY  
DURING 1909-1911

Locality	No. of fruits	Av. diam.	D/H index
(1) Sodeshi, Iwara-gun, Shidzuoka-ken ("Kanro" of Mr. SAWANO)	3	6.53 cm.	1.57
(2) ditto (unnamed lot)	2	6.75	1.37
(3) Tosa, Shikoku Island (TAMURA's "Owari")	3	6.87	1.44
(4) Sagami, Kanagawa-ken	5	6.93	1.43
(5) ditto (TOKIWA's orchard)	4	6.62	1.45
(6) Maegawa, Sagami, Kanagawa ken (Mr. SHIINO's)	7	5.88	1.46
(7) Idzumi, Ôsaka-fu (MORI's "Owari")	3	6.54	1.52
(8) Okitsu, Shidzuoka-ken	3	7.67	1.43
(9) Yamakita, Kanagawa-ken	1	6.30	1.40
(10) Kosaka, Shidzuoka-ken	1	7.50	1.50
(11) Yuidzu, Shidzuoka-ken	3	7.40	1.44
(12) Sugiyama, Shidzuoka-ken	3	6.98	1.37
(13) ditto (KATAHIRA's)	3	6.77	1.38
Totals	41	Av. 6.82 cm.	Av. 1.44

Plants of Tanushimaru origin, observed during this period, revealed another point of difference. The tree is not so dwarf as the Ikeda and attains to a large size, but the leaves are not so conspicuously luxuriant as in the Owari. Fruits are generally large and flat, but not obconical as in the latter, and are more or less symmetrically depressed globose,

like those of Kunembo. The rind is usually thick, and the pulp is coarse in texture and less palatable. Such plants are common in old groves in Kyushu Island, where neither Ikeda nor Owari plants were distributed. The fruits borne on the huge Satsuma tree in Fukutomi, Fukuoka-ken, are representative of this type. This tree, about which mention is made in a later chapter, and similar old trees, furnished budsticks to Tanushimaru for many years. The writer provisionally called this "Zairai", or primitive variety.

The measurement of this type is given in Table 5.

TABLE 5.  
MEASUREMENT OF SATSUMA FRUITS "ZAIRAI" VARIETY DURING 1909-1911

Locality	No. of fruits	Av. diam.	D/H index
Yanagawa, Fukuoka-ken	2	7.25 cm.	1.38
Kawachi, Kumamoto-ken	2	7.20	1.54
Aoe, Oita-ken (KAWANO's)	4	6.72	1.31
ditto (KUBOTA's)	4	6.59	1.35
Kajiki, Kagoshima-ken	4	6.85	1.37
Obi, Miyazaki-ken	2	7.04	1.34
Tokudani, Fukuoka-ken	3	6.41	1.37
Tachibana, Kasuya-gun, Fukuoka-ken	3	6.14	1.43
Yoshinmo, Kagoshima-ken	2	7.03	1.50
ditto	2	7.20	1.39
Sakurajima, Kagoshima-ken (FUKUZAKO's)	2	6.58	1.26
Fukutomi, Fukuoka-ken (Largest tree recorded by Kumanosuke ABE)	6	6.82	1.31
Totals	36	Av. 6.82 cm.	Av. 1.37

Besides these three distinctive classes of fruits developed independently from different nursery districts, there are small localities having characteristic fruits. In Tachima, Ehime-ken, there developed a flat Satsuma called "Hira". Some fruits obtained during this period proved to be most likely this kind. Table 6 shows the measurement of the fruit coming from this locality.

TABLE 6.

MEASUREMENT OF SATSUMA FRUITS FROM TACHIMA, EHIME-KEN, OR OF THE SAME ORIGIN

Locality	No. of fruits	Av. diam.	D/H index
Tachima, Ehime-ken, Shikoku Island.	1	7.40 cm.	1.75
ditto (purchased in Tokyo)	4	7.25	1.52
Tosa, Shikoku Island (TAMURA's "Hira")	3	7.25	1.49
Totals	8	Av. 7.30 cm.	Av. 1.59

Ikiriki, in Nagasaki Prefecture, is another place where a local Satsuma industry developed without the introduction of nursery plants from the professional nursery districts. The type of fruit growing there is very much like that of Owari Province, large sized, somewhat conical, and intensely sweet. The plant usually has large leaves of a deep green color. Since the color of the fruit is very deep, rind thick, and the crater-like excavated stem-end very marked, it was considered a separate variety, provisionally called "Ikiriki". The measurement of Ikiriki fruit is given in Table 7.

TABLE 7.

MEASUREMENT OF SATSUMA FRUITS FROM IKIRIKI, NAGASAKI-KEN, OR OF THE SAME ORIGIN

Locality	No. of fruits	Av. diam.	D/H index
(1) Ikiriki, Nagasaki-ken	1	7.40 cm.	1.40
(2) Nagasaki Agr. Exp. Stat. ("Ikiriki")	2	7.00	1.37
(3) Ikiriki, Nagasaki-ken (TANAKA's)	2	7.03	1.41
(4) ditto (MORI's)	4	6.61	1.43
(5) ditto (grower unknown)	1	7.25	1.42
Totals	10	Av. 7.06 cm.	Av. 1.41

KADOOKA<sup>(40)</sup>, compared the fruits of Ikiriki village and those of



Wakayama Prefecture, sent from Tanaka-mura, Naka-gun, by Mr. H. TATE. The result of his statistical investigations was as follows:

Material	D/H index	
	Average	Variation coefficient
From Wakayama Prefecture	$1.2689 \pm 0.0033$	$4.27 \pm 0.18$
From Ikiriki	$1.3912 \pm 0.0049$	$5.72 \pm 0.25$

This shows that the fruits of Ikiriki are flatter than those of Wakayama, and slightly more variable in shape. The Wakayama material was probably taken from a tree of Ikeda origin.

The most striking result of the study during this period is the discovery of the Wase variety, which was published by the writer under a varietal name, "*praecox*", in 1912<sup>(13\*)</sup>. Prior to this time, Wase Satsuma had been practically unknown, except that AKIMITSU<sup>(4)</sup> reported it as "Sakigake" (Forerunner). The fruit of Wase is quite distinct from all other kinds by reason of its large-sized and very heavy fruits with polished, thin rind, large oil cell dots widely spaced, very large pulp vesicles, and large calyx surrounded by a flat, much extended disk ring. The Wase tree in Japan is rather dwarf, having smaller, light-colored leaves somewhat twisted at the middle. The measurement of the fruit of this distinct variety is shown in Table 8.

TABLE 8.  
MEASUREMENT OF SATSUMA FRUITS OF WASE VARIETY STUDIED  
DURING 1909-1911

Locality	No. of fruits	Av. diam.	D/H index
(1) Hisatomo, Hiroshima-ken	10	6.67 cm.	1.39
(2) Hiroshima (through Nagasaki Exp. Stat.)	1	7.30	1.30
(3) Tsukumi, Ōita-ken	3	6.55	1.28
Totals	14	Av. 6.84 cm.	Av. 1.33

As to abnormal strains of the Satsuma orange, the writer has noted several kinds. The first is a corrugated Satsuma received from the Wakayama Citrus Growers' League, there called "Kiku" (*Chrysanthemum*). Four fruits received were uniformly small, flat, deep-colored, and with very clear corrugation throughout the surface. The average diameter of these fruits was 5.45 cm., and the D/H index was 1.30. The tree was not studied, and no further information about the owner of the tree was received.

The second is a variegated Satsuma, with clear, light-colored stripes on the surface of the fruit. The fruit was grown at Minoshima, in Wakayama Prefecture; its diameter was 5.6 cm. and the D/H index 1.11. Nursery plants of a variegated Satsuma have been distributed from the Ikeda district for ornamental purposes,\* but the above mentioned fruit was possibly taken from a bud sport found in an ordinary Satsuma orchard.

There have been received several other sorts from old localities, the origin of which was impossible of determination. They were mostly from south-western Japan, including Shikoku Island. The above statistical studies are summarized in Table 9, so as to afford a comparison of the different types of fruit observed during this period.

TABLE 9.  
TYPES OF SATSUMAS FROM DIFFERENT LOCALITIES SUPPOSED TO HAVE  
DIFFERENT ORIGIN

Origin (or variety name)	Total No. of fruits studied	Av. diam.	D/H index
(1) Ikeda **	34	5.57 cm.	1.23
(2) Owari	41	6.82	1.44
(3) Tanushimaru ("Zairai")	36	6.82	1.37
(4) Tachima ("Hira")	8	7.30	1.59
(5) Ikiriki	10	7.06	1.41
(6) Wase	14	6.84	1.33

\* See Nursery Catalogue of YAMANAKA, Tsunesaburô, titled "Shokubutsu Jubyô Hôchi" (Report of Nursery Plants) from Nagao-mura, Kawabe-gun, Hyôgo-ken.

\*\* Tabulated from Table 2, and Table 3.

This preliminary study shows that these types of Satsuma, having different origins, differ fairly well from one another. Those of Ikeda have a conspicuously small and rounded fruit, those from Owari and Tanushimaru are of a nearly equal size, but the former is more flat. Hira, from Tachima village in Ehime Prefecture and the fruit from Iki-riki village, Nagasaki Prefecture, have a larger fruit; the former having a very flat form, while the latter is taller than Owari and flatter than Tanushimaru. Wase fruits are nearly as large as those of Owari and Tanushimaru, but are less flattened.

### FURTHER STUDIES IN THE CHARACTER OF SATSUMA FRUITS

In the fall of 1911, the Horticultural Department of the Imperial Agricultural Experiment Station at Okitsu, headed by Dr. T. ONDA, undertook to collect representative Satsuma fruits from all the growing districts in Japan, and to investigate their characteristics; the writer was invited to join in the investigation of these fruits. 37 different lots were received from 28 different localities. The investigation of the exterior characters of the first 28 lots was conducted by the writer and the rest of the fruits, together with the interior characters of the whole lot, were examined by Messrs. T. TANIKAWA and C. MATSUDAIRA, of the station. The result of measurements obtained by the writer is given in Table 10.

TABLE 10.  
MEASUREMENT OF SATSUMA FRUITS FROM VARIOUS LOCALITIES IN JAPAN  
CLASSIFIED ACCORDING TO THE POSSIBLE ORIGIN OF PLANTS

Locality	No. of fruits	Av. diam.	D/H index
(A) <i>Ikeda origin</i>			
(1) Naka-gun, Wakayama-ken (HORIUCHI's)	12	7.81 cm.	1.39
(2) Kasahi-mura, Ito-gun, Wakayama-ken (Growers' League)	8	7.08	1.37
(3) ditto (Improved)	8	7.34	1.32

TABLE 10.—(Continued)

Locality	No. of fruits	Av. diam.	D/H index
(4) Mitsu-mura, Hoi-gun, Aichi-ken*	7	6.45 cm.	1.37
Totals	35	Av. 7.17 cm.	Av. 1.36
(B) Owari origin			
(1) Kusagaya, Iwara-mura, Shidzuoka-ken	10	7.62 cm.	1.46
(2) Yamataki-mura, Senhoku-gun, Ôsaka-fu (ÔUYE's)	6	6.76	1.43
(3) Osada-mura, Abe-gun, Shidzuoka-ken (OGAWA's)	10	7.70	1.40
(4) ditto (MASUDA's)	13	8.04	1.47
(5) Maegawa, Kanagawa-ken (Arg. Exp. Stat.)	8	6.82	1.45
(6) Aichi Agr. Exp. Stat. (per ICHIKAWA)	7	7.37	1.45
(7) Kaidzu-gun, Gifu-ken	6	6.16	1.45
(8) Shida-gun, Cit. Grow. League, Shidzuoka-ken	10	7.60	1.43
(9) Hamana-mura, Inasa-gun, Shidzuoka-ken	10	7.00	1.40
(10) Takabe-mura, Iwara-gun, Shidzuoka-ken	8	6.92	1.42
(11) Yamataekami-mura, Senhoku-gun, Ôsaka-fu (MORI's "Owari", giant)	6	7.93	1.51
(12) Ôchô-mura, Toyoda-gun, Hiroshima-ken	8	7.34	1.56
(13) Kanbara, Iwara-gun, Shidzuoka-ken	10	7.19	1.40
Totals	112	Av. 7.27 cm.	Av. 1.45
(C) Tamushimaru origin (or similar origin)			
(1) Hirabaru, Higashimatsuura-gun, Nagasaki-ken (IWAMUNE's large sized)	7	7.47 cm.	1.39
(2) ditto (YOSHIMURA's small sized)	7	6.79	1.40
(3) ditto (IYAMA's medium sized)	7	7.21	1.39
(4) Kushige-mura, Yame-gun, Fukuoka-ken	7	7.22	1.48
(5) Aoe-mura, Kitaamabe-gun, Ôita-ken	8	7.10	1.40
(6) ditto	8	7.01	1.44
(7) Tsukumi-mura, Kitaamabe-gun, Ôita-ken	10	7.12	1.49
(8) Kôchi-ken (Agic. Soc.)	7	6.60	1.38
(9) Yanagawa, Yame-gun, Fukuoka-ken (TACHIBANA's)	5	7.34	1.44
Totals	66	Av. 7.14 cm.	Av. 1.42
(D) Wase Satsuma			
(1) Ôchô-mura, Toyoda-gun, Hiroshima-ken	8	7.67 cm.	1.46
(2) Tsukumi-mura, Kitaamabe-gun, Ôita-ken	7	7.68	1.41
Totals	15	Av. 7.68 cm.	Av. 1.44

It is doubtful about the origin of this lot, though the fruits are typical for this group.

Unfortunately, the materials from Ehime (representing "Hira") and Nagasaki (representing "Ikiriki") did not come in time and were unavailable for study. The grouping of the material was made by the writer, and not by the Station. No interpretation was made or no report was published by the Station, although some comment was made in a current horticultural journal about it\*. It is, however, obvious from the table that the type of fruits of different origins show an expected difference fairly well, although the shipments did not represent "average" samples\*\*. Wase showed its full grown size, and was remarkable in appearance, but the fruit was all over-ripe since it was kept until the middle of December, almost two months later than the season of its full maturity. Those of Ikeda origin showed a comparatively large size, and the samples were either choice pick or a particular strain isolated from the ordinary type. Collecting samples from the average grower without any specification generally brings extra-large, beautiful-looking, flat fruits, so that the average of such a sample is much flatter than the whole population. This is well shown in the case of the flatness of the Wase fruits received. At any rate, the result of any study based upon a choice pick from a number of trees means very little in determining the accurate status of different varieties. Samples for the study of minor differences must be carried out from a genetical standpoint. Such a sample must be taken from a definite tree, kept separate from other samples, and must be separately measured and compared. If possible, measurements of fruit from such trees should be repeated from year to year, and result will then be of a decisive nature. Such a method is, however, very difficult to undertake. A trial study was formulated in connection with cross pollination experiments during the years 1912 to 1914, and the result will be seen in the next chapter.

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\* See Anonymous. Zenkoku Unshû Mikan no Hinshitsu (Quality of Satsuma from all parts of Japan) in Kwaju (Fruit Tree) no. 107, p. 38-40. M. 45 (1912).

\*\* Circular letters sent to the collectors requested them "to send until 5th. December, 7 fruits each representing materials of superior types common in the locality, characterized by their shape" but this passage was taken by a great majority of senders to mean "select materials which possess the characteristic shape common in the locality." Consequently, a lot of unusually beautiful specimens were received.

## STATISTICAL DATA OF THE FRUIT CHARACTERS OF IKEDA TREES

Eighteen small Satsuma trees of uniform size and form were taken for study in the writer's experimental orchard at Maitani, near Ikeda, Kawabe-gun, Hyôgo-ken. All trees came from the Ikeda nurseries, and the fruits first studied in 1911 were uniformly small and round. Uniform treatment was given during the period of experiment, i. e., 1912 to 1915. Eight trees were used for one year only, seven trees were studied in two successive years, and four trees studied for three years. The result of measurements of the fruit diameter, height, and diameter-height index are given in Table 11.

TABLE 11.

MEASUREMENT OF SATSUMA FRUITS OF IKEDA VARIETY, BORNE ON  
INDIVIDUAL TREES DURING THE YEARS 1912-1914, AT TANAKA'S  
EXPERIMENTAL ORCHARD, MAITANI, JAPAN

Tree No.	Year	No. of fruits	Av. diam.	Av. height	D/H index	Notes on crop
20	1912	91	cm. 5.70	cm. 4.50	1.27	Of good size and taste.
	1913	68	5.68	4.42	1.29	Size not uniform, taste inferior: one branch with uniform crop.
	1914	58	5.41	4.33	1.25	Tall and tight-skinned.
22	1912	14	6.41	5.06	1.29	--
	1913	79	5.36	4.13	1.30	Well graded, smooth and solid.
	1914	15	5.72	4.48	1.28	Rather irregular crop, scabby.
25	1912	10	5.37	4.41	1.22	—
	1913	26	5.21	4.24	1.23	Rather tall, not uniform.
	1914	74	5.15	4.21	1.22	Generally tall.
27	1912	39	5.82	4.87	1.20	—
	1913	51	5.64	4.40	1.23	Generally tall and smooth: one branch with flat fruits.
	1914	19	5.50	4.57	1.21	Good sized but tall, thick-skinned.

TABLE 11.—(Continued)

Tree No.	Year	No. of fruits	Av. diam.	Av. height	D/H index	Notes on crop
26	1912	11	cm. 6.53	cm. 5.26	1.24	—
	1913	15	5.95	4.51	1.32	Well graded, tall, bright colored.
31	1913	28	6.23	4.59	1.36	Flat, smooth, well colored.
	1914	22	5.40	4.22	1.23	Rather irregular crop.
33	1913	31	5.09	3.89	1.31	Rather flat, smooth, well graded.
	1914	20	5.01	4.13	1.21	Irregular, many culls.
34	1913	89	5.30	4.12	1.23	Very well graded, tall, smooth.
	1914	10	5.34	4.38	1.22	Irregular, mixture of tall, rough fruits.
35	1913	19	5.85	4.41	1.33	Of good size and color, smooth.
	1914	1	4.50	3.38	1.33	Small, flat, smooth fruit.
36	1913	30	5.30	3.85	1.38	Characteristic, flat and smooth.
	1914	18	5.13	3.61	1.42	Small but uniformly flat.
37	1913	2	5.27	3.88	1.36	Smooth, flat fruits.
	1914	2	5.12	3.92	1.31	Small and round.
11	1912	50	4.99	4.16	1.20	Rough looking.
12	1912	8	6.14	5.08	1.21	—
17	1912	1	5.33	4.40	1.21	—
32	1913	38	5.50	4.43	1.24	Well graded, taste good.
38	1913	34	5.80	4.63	1.27	Rather tall, compact, not well colored.
39	1913	27	5.98	4.51	1.33	Puffy, bright colored, taste good.
40	1913	21	5.87	4.55	1.29	Puffy, tall, rough.
46	1914	49	5.39	4.29	1.26	Generally tall.

From this table, the following conclusions can be drawn :

- (1) Crops of the same tree in different years are generally similar, except in years producing an irregular crop.

It is noticeable that such a tree as No. 36 bore uniformly flat fruits every year. Tree No. 25 was just the opposite and bore tall fruits yearly.

- (2) A tree in a single year has never produced different types of fruits. The average flatness, D/H index, is small in every case, ranging from 1.20 to 1.36 except Tree no. 36, above mentioned. Tree No. 31 might rank with the above but its 1914 crop was rather abnormal and was not uniformly flat. In the great majority of cases, the D/H index was smaller than 1.30 and the fruits really looked round, more or less thick, and tight-skinned.
- (3) No large difference in the shape of the fruit is found in different parts of the tree. In 1913, Tree No. 27 bore rather flat fruits. The western branch appeared to bear taller faults than that of eastern branch, but the statistical figures of fruits from both branches are practically the same as formulated below :

	No. of fruits	Av. diam.	Av. height	D/H index
1. Western branch	23	5.62 cm.	4.40 cm.	1.28
2. Eastern branch	28	5.70	4.41	1.28

- (4) The general average of the D/H index of all the trees is 1.2736, and the average deviation of each individual tree from this total value is greater than the average of the annual deviation of each tree. This means that the individuality of each tree is stronger than its annual fluctuation of crops. The average annual deviation of the first eleven trees (employed for the study more than two successive years), computed from Table 12, is  $\pm 2.9002\%$ , while the average tree deviation (from general averages) of the same is  $\pm 5.2723\%$  and of the whole trees is  $\pm 5.0711\%$ , both being far greater than the former. The figures are shown in Table 12.
- (5) It is perceived from Table 12 that a tree like No. 36, previously mentioned, is very far from the average (deviation figured as  $\pm 12.64\%$ ). The record reveals that this particular tree every year bears corrugated fruits, which are different in other characters, as in the prominence of an areola and an abruptly depressed apex. If this plant is discarded from the average, the average D/H index of all the trees becomes 1.2666 instead of 1.2736.



TABLE 12.

COMPUTATION OF THE VALUE OF D/H INDEX OF EACH TREE SEPARATELY,  
WITH ITS ANNUAL DEVIATIONS AND AVERAGE DEVIATIONS FROM  
D/H INDEX OF ALL TREES

Tree No.	Year	D/H index	Av. D/H index for each tree	Deviation of annual value	Average deviation of each tree	D/H index compared with all trees
				(%)	(%)	(%)
20	1912	1.27	1.2700	0	± 1.63	- 0.36
	1913	1.29		+ 2		
	1914	1.25		- 2		
22	1912	1.29	1.2900	0	± 0.82	+ 1.64
	1913	1.30		+ 1		
	1914	1.28		- 1		
25	1912	1.22	1.2233	- .33	± 0.54	- 5.03
	1913	1.23		+ .67		
	1914	1.22		- .33		
27	1912	1.20	1.2300	- 3	± 3.56	- 4.36
	1913	1.23		+ 5		
	1914	1.21		- 2		
26	1912	1.24	1.2800	- 4	± 4.00	+ 0.64
	1913	1.32		+ 4		
31	1913	1.36	1.3200	+ 4	± 4.00	+ 4.64
	1914	1.23		- 4		
33	1913	1.31	1.2600	+ 5	± 5.00	- 1.36
	1914	1.21		- 5		
34	1913	1.28	1.2500	+ 3	± 3.00	- 2.36
	1914	1.22		- 3		
35	1913	1.33	1.3300	0	0	+ 5.64
	1914	1.33		0		
36	1913	1.38	1.4000	- 2	± 2.00	+ 12.64
	1914	1.42		+ 2		
37	1913	1.36	1.3350	+ 2.5	± 2.50	+ 6.14
	1914	1.33		- 2.5		

TABLE 12.—(Continued)

Tree No.	Year	D/H index	Av. D/H index for each tree	Deviation of annual value	Average deviation of each tree	D/H index compared with all trees
				(%)	(%)	(%)
11	1912	1.20	—	—	—	— 7.36
12	1912	1.21	—	—	—	— 6.36
17	1912	1.21	—	—	—	— 6.36
32	1913	1.24	—	—	—	— 3.36
38	1913	1.27	—	—	—	— 0.36
39	1913	1.33	—	—	—	+ 5.64
40	1913	1.23	—	—	—	+ 1.64
46	1914	1.26	—	—	—	— 1.36
Average	—	—	1.2736	—	± 2.9002	± 5.0711

- (6) This figure, approximately 1.27, approaches the previous figure for Ikeda trees (Table 9), i. e., 1.23 (1.17-1.29). It may be said, therefore, that the Ikeda is almost definitely a uniform variety as far as the shape of the fruit is concerned. And there are many associate characters to sustain this view. The fruit is generally tight-skinned, thicker rinded, more or less compact with a somewhat protruded base with a small calyx generally abruptly sinuate. The percentage of fruit with navel opening is very small, and the areola around the styler end is not pronounced. Segments are few in number, the central column is small and the segment wall is rather thick. Pulp vesicles are more elongated than reticulated, thick walled, and the juice is late maturing. These characteristics were noticeable throughout the period of examination.

### PRELIMINARY CONCLUSION ON THE VARIETIES OF SATSUMA ORANGE IN JAPAN

In 1918, after the investigation of previous data and repeated surveys in the United States in 1917-1918, the writer first published a description of six varieties of the Satsuma orange<sup>(140)</sup>. The descriptions reported in this publication are as follows:

(1) IKEDA.—Tree spreading and branching low; the foliage is rather open and hanging; leaves small, narrow, tapering, the margin near the base frequently concave, petiole wing very small; fruit small, rounded; rind coarse and thick, deeply colored, with large, conspicuous oil cells; little rag; segment walls rather thick; pulp of deep color, fine grained, of excellent flavor; seeds very few. Originated at Hosokawa-mura, Toyono-gun, Ōsaka-fu.

(2) OWARI.—Tree of upright habit, branches few and vigorous, foliage dense, rather stiff and upright, especially on the upper branches; leaves large and broad, especially broad at the base, where the margin is convexly curved, deeply colored, petiole wing of medium width. Fruits are large and flattened, with depressions at both stem and blossom ends, often showing an inconspicuous navel marking; rind thin, smooth, and deeply colored, oil cells small; little rag; segment walls thin; pulp finely grained, of good quality, and deep color; nearly or quite seedless. Origin not known: Distributed extensively from Nakajima-gun, Aichi-ken.

(3) ZAIRAI.—Tree of upright habit; leaves large, with rather broad petiole wing; fruit large, flattened, fairly symmetrical; rind rough, deeply pitted, thick, segment walls thick; rag pronounced; pulp of light color, coarse, and of inferior flavor; usually seedy. Common in Chikugo Province, Fukuoka-ken.

(4) HIRA.—Tree not seen: Fruit is large, flattened, and symmetrical in form; rind fairly smooth, rather thick, not deeply colored; segments often separated by a slight cavity; central column comparatively small; pulp of light color, coarse, of mild flavor; usually seedless, but not always so. Known only in Tachima mura, Kitauwa-gun, Ehime-ken.

(5) IKIRIKI.—The tree of vigorous appearance, with a thick trunk and branches and with very large, deep colored leaves. The fruit is also very large, blossom end flattened, and this half of the fruit distinctly larger than the stem end. The tapering stem end with flattened blossom end is characteristic of this variety. The rind is deeply colored, thick, deeply pitted with large oil cells, with a large amount of soft rag; segment walls thick and soft, adhering to the pulp; pulp of pale color, fine grained, of mild flavor; usually having few seeds. Extensively grown in Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken.

(6) WASE.—Trees are upright, rather weak and dwarfened; leaves small, generally upright; foliage dense, tinged with yellow; fruits very large, flattened, especially at blossom end, of characteristic rectangular outline in longitudinal cross section; surface of rind smooth, slightly pitted, deeply colored when fully matured; calyx very large and strongly attached to the fruit, which usually has double rings in the rind closely surrounding the calyx; rind remarkably thin and fitting-closely to the segments; oil cells large and numerous; segment walls flexible; pulp rather faintly colored, flavor only fair, mildly acid; usually seedless. Originated at Aoe-mura, Kitaamabe-gun, Ōita-ken.

## VARIETIES OF THE SATSUMA ORANGE IN THE UNITED STATES

The preliminary description of the Satsuma varieties given above was later found to be not thoroughly satisfactory and was made subject to revision. An extensive study made in the fields of Alabama, Mississippi, and northern Florida in the years 1917-1918, brought very much more material for variety segregation. Orchard determination of varieties

conducted during this period met with much difficulty on account of the great difference of cultural conditions from the Japanese grooves. Moreover, the time when the investigation was made was not normal, being after damage by cold and wind, and the work had to be gone through often without making a study of the fruit. Many orchards were abnormal in condition, having not fully recovered from the damages, or were badly neglected. When good fruiting material was available, the distinction between such varieties like Ikeda and Owari was comparatively easy. No plant typical of Hira, Ikiriki, and Wase was found in the Gulf States. A few Zairai-like plants were observed but most of them turned out to be Owari in later years, after reaching full bearing.

Although this study was of a preliminary nature, and a few preliminary publications by L. B. SCOTT\* were issued, it seems worth while to record some of the results obtained, merely as a record of scientific interest. Table 13 presents the data; the names of orchards were omitted, because they were not only unnecessary for this report, but also as a precaution to avoid misinterpretation.

From this preliminary observation, the distinction between Ikeda and Owari varieties became fairly clear. The Owari leaves are generally larger and broader, are more rounded at the apex and broader angled at the base, and the petiole wing is slightly broader. The Ikeda leaves are smaller, narrower, more pointed at the apex, and narrow-angled at the base, and the petiole wing narrower. The Owari tree has more upright shoots, is more vigorous and densely foliated, more branches coming out from the lower part of the plant. The Ikeda tree has more delicate drooping branches, is less vigorous, and the foliage is more open, few branches coming out at the lower part of the plant. The young nursery plant of the Owari occasionally bears thorns, while the Ikeda plant never produces thorns. The fruit of the Owari is generally flat, obconical, maturing earlier, with thinner rind and less pronounced foveoli. Ikeda fruits are more roundish and occasionally much narrowed at the base or sometimes

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\* Mr. SCOTT, to whom the author's warmest acknowledgment is due, was formerly pomologist of the office of Horticultural and Pomological Investigations, U. S. Department of Agriculture, and assisted in the author's field work during this period.

pear-shaped, the rind is thicker, later coloring, and more pitted. In halving the fruit, the Ikeda is found generally with a fewer number of segments, a smaller central column, and thicker segment wall, while the Owari fruit has usually a larger number of segments, a larger central column and thinner segment walls. The fruit of the Owari shows the open navel marking more frequently than the Ikeda.

TABLE 13.

MEASUREMENT OF SATSUMA FRUITS COLLECTED FROM VARIOUS ORCHARDS  
IN THE GULF STATES DURING THE YEARS 1917-1918

Variety	Orchard No.	No. of fruits	Girth	Diameter	Height	D/H index
<i>IKEDA</i>	( 1 )	2	cm. 20.6	cm. 6.50	cm. 5.65	1.17
"	( 2 )	3	18.4	5.78	4.43	1.29
"	( 3 )	2	23.7	7.00	6.10	1.15
"	( 4 )	3	19.2	5.93	4.70	1.26
"	( 5 )	3	19.8	5.70	4.88	1.17
"	( 6 )	1	18.8	6.00	4.60	1.30
"	Average	—	20.1	6.15	5.06	1.22
<i>OWARI</i>	( 7 )	3	20.2	6.38	4.42	1.43
"	( 3 )	6	18.3	5.73	4.21	1.36
"	( 8 )	2	18.0	5.60	3.88	1.44
"	( 4 )	3	18.6	5.89	4.13	1.42
"	( 6 )	1	17.8	5.60	4.00	1.40
"	( 9 )	5	18.7	5.93	4.10	1.45
"	(10)	2	18.4	5.75	4.15	1.39
"	(11)	2	20.6	6.45	4.45	1.45
"	Average	—	18.7	5.92	4.17	1.42
<i>INTERMEDIATE</i> (tentatively called <i>Zairai</i> )	(12)	4	20.2	6.27	4.50	1.39
"	(13)	2	21.4	6.70	5.00	1.34
"	( 4 )	2	20.2	6.33	4.87	1.30
"	(14)	2	20.1	6.31	4.90	1.28
"	Average	—	20.5	6.41	4.82	1.33

## FURTHER STUDIES IN SATSUMA VARIETIES IN JAPAN

From the winter of 1918, the writer resumed the survey of Satsuma varieties again in Japan. Not only the reinvestigation of commonly cultivated varieties but the finding of some rare, worthy strains were the principal aims of this study. Up to the spring of 1921, the investigation continued and the whole work was done in cooperation with the U. S. Department of Agriculture. At the opening of the study, the former method of investigation was followed. Fruit collected from the tree was first measured three times; first, girth, second, maximum and minimum diameter, and third, height. Sketches of the outline of each fruit studied were taken, and in many cases photographs were also taken. Calyx and navel mark, if existent, were also sketched. After the fruit was transversely halved, records were taken on the number of segments, the thickness of the rind in mm., the maximum and minimum diameter of the central column, and the number of seeds. In many cases a sketch of the shape of the central column was made.

### MORI'S LARGE FRUITING OWARI

In connection with the search for a large fruiting strain of the Owari variety, MORI's so-called giant fruiting plants were first studied. A preliminary account of this has been given by the writer before<sup>(140)</sup>. The fruits were so celebrated that MORI's fruit only was selected for the privilege of presentation to the Imperial Household, and medals were repeatedly awarded in various fruit fairs. A branch with fruits, from his tree, exhibited by Hyôemon TATE, won the highest prize at the National Exposition of 1903. A visit to MORI's orchard at Kônoyama near Inaba, Yamataekami-mura, Senhoku-gun, Ôsaka-fu, brought new information. It was found that the trees bearing giant fruits are not a few, but many, comprising a large part of a planting on a small hilly ridge extending westward. The soil looked similar to that of other parts of the orchard, being freshly decomposed granite with a comparatively small amount of organic matter. The nursery plants all came from a single nurseryman called Tôhei YOSHIDA, of Horinouchi, Toyoda-mura, Nakajima-gun, Owari

Province (Aichi-ken). Mr. MORI owns about 12 chô (11.9 hectares) of Satsuma orchard planted with about 10,000 trees, but the lot in question consists of about 1500 trees planted in 1898. In planting the nursery trees, it was said that utmost care was taken not to include weak-looking forked trees, and many plants were discarded from the shipment lot. It was afterwards found that T. YOSHIDA is a very skilled nurseryman, having won a prize by raising 1000 yen from 24.3 ares, through breeding flowering apricots and roses. He raised his Satsuma trees himself but the original buds came from very vigorous thorny trees found in the yard of Jin'ichirô TOMIDA, they most probably being apogamic seedlings. Another point in bringing about this giant fruiting strain is the immediate planting of vigorous two-year old grafts. Occasionally such grafts lose their vigor if kept stunted in the nursery under unfavorable conditions. At any rate, MORI's large fruiting Satsumas are individually so characterized through their particular origin, and are associated with good local conditions and careful selection. Observations of a few fruits from the Kônoyama orchard are given below: Samples were all taken on Nov. 17, 1918.

(1) From the first tree on the hill-ridge path, left hand side just above a hut. 2 f | completely depressed; average girth 24.4 cm.; average diameter 7.65 | average height 5.4 cm.; D/H index 1.42; no navel. No. of segments, | and 12; rind about 3-5 mm. thick; central column about 18 mm. diam.; contains no seed. One fruit sweet and delicious, the other slightly subacid, but rich in sugar.

(2) From the second tree, a little lower down from the first tree (left turn to the valley). Three fruits about the same size and shape, completely flattened, with large calyx. Average girth 23.8 cm.; average diameter about 7.50 cm.; average height 5.3 cm.; D/H index 1.42; navel slightly opened or closed. No. of segments 10 to 12; rind 2.5-5 mm.; central column from 14 to 16 mm.; completely seedless. Rich in quality but slightly subacid.

(3) From the third tree, farther up the hill, left side on the path. Four fruits taken. About same in size and shape, except the third fruit which was abnormal and so discarded. Average girth of three

typical fruits 24.5 cm.; average diameter 7.52 cm.; average height 5.3 cm.; D/H index 1.42; navel wide open. No. of segments 11 to 13; rind 2.5-4 mm.; central column about 17-21 mm.; seed none. Quality good, slightly subacid.

(4) From the fourth tree, on the hill top near a land slide. This tree was said to bear regularly every year. Three fruits were taken, all equally flat, and of enormous size, the largest measuring 28.7 cm. in girth and 8.65 cm. in diameter. Average girth of three fruits 26.0 cm.; average diameter 8.08 cm.; average height 5.53 cm.; D/H index 1.425; no navel. No. of segments 11; rind 3.5-4.5 mm.; central column not large, 16 to 19 mm.; no seed. Quality good to medium.

The general appearance of the fruit of the whole lot was rather rough, due to the concave oil cell dots. The fruits were heavy and compact, their shape was typically more or less obconical; the flattened area at the apex was conspicuously large, and the crater-like depression was also typical of Owari.

The fruits collected were all subject to a "second pick", conducted about the 10th of December, being more or less green, not fully matured, and not of standard grade in flavor. The thickness of the rind and the size of the central column were moderately small in proportion to the size of the fruit. No puffiness of the rind was shown.

Examples were also taken of the shape of the leaf. The characters of the leaf strictly agreed with Owari in every respect. They were all broad, convex at the base, and not tapering at the apex. The measurements of the length and breadth of the leaf are given in Table 14. Small deformed leaves at the top of the branch were not measured. Both figures for length and breadth are arranged from the largest to the smallest. They are given in centimeters.

The fertilizing and treatment of MORI's plants will give a general idea of the best Japanese way of handling the Satsuma trees. Mr. MORI gives only a shallow hoeing four or five times a year during the season from February to June. It is not necessary to plough deep because of the nature of the soil, which is very coarse sand. Angular gravel is much welcomed in the orchard, but no extensive stone terrace was built.



2.5 to 3 shô (4.5 to 5.5 litres) of fish-cake (3 kinds mixed) are used per tree of 30 years of age. This is divided into two portions of 6:4, the first being applied in winter and the second in spring. Picking begins about the 19th of December and all picked fruits are stored until February and March of the next year, in a storage constructed to fit the purpose, a pile store house without refrigeration. Most of the fruit is marketed in Ôsaka and Tôkyô.

TABLE 14.

MEASUREMENT OF THE LEAVES OF MORI'S LARGE FRUITING OWARI  
SATSUMA FROM FOUR REPRESENTATIVE TREES IN  
KÔNOYAMA ORCHARD AT INABA, ÔSAKA-FU

Tree 1. (L=length. B=breath.)

L.	12.6	11.2	11.0	10.5	9.3	9.3	8.9	Average 10.4 cm.						
B.	5.0	4.7	4.6	4.3	4.2	4.0	4.0	Average 4.4 or 42.3 % of the L.						

Tree 2.

L.	12.5	12.0	11.8	11.8	11.7	11.4	11.3	11.2	11.0	11.0	11.0	10.6	10.5	10.3	10.2
	10.1	10.1	10.0	1.00	10.0	9.6	9.3	9.2	9.2	9.2	9.2	9.0	9.0	9.0	8.7
	8.6	8.5	8.3	8.2	Average 10.1 cm.										
B.	5.4	5.1	4.8	4.8	4.8	4.7	4.7	4.6	4.6	4.6	4.5	4.5	4.5	4.5	4.3
	4.2	4.2	4.1	4.0	4.0	4.0	4.0	4.0	4.0	3.8	3.7	3.7	3.7	3.7	3.6
	3.5	3.4	3.4	3.3	Average 4.2 or 41.8 % of the L.										

Tree 3.

L.	12.4	12.4	11.7	11.3	10.9	10.9	10.8	10.7	10.7	10.6	10.5	10.5	10.4	10.4	10.4
	10.3	10.3	10.1	9.9	9.9	9.9	9.6	9.5	9.3	9.2	9.2	8.8	8.8	8.3	8.0
	Average 10.2 cm.														
B.	5.2	5.2	5.1	5.0	4.9	4.9	4.8	4.7	4.7	4.7	4.7	4.7	4.6	4.6	4.6
	4.6	4.5	4.4	4.4	4.3	4.3	4.3	4.3	4.2	4.1	4.0	4.0	3.9	3.8	3.3
	Average 4.5 or 44.1 % of the L.														

Tree 4.

L.	12.1	11.2	11.1	11.0	10.7	10.5	10.4	10.0	10.0	9.8	9.6	9.5	9.5	9.0	8.9
	8.7	8.7	8.5	8.1	7.7	7.7	7.5	7.5	6.5	Average 9.34 cm.					
B.	5.4	5.3	4.8	4.8	4.8	4.7	4.6	4.5	4.5	4.4	4.3	4.3	4.2	3.6	3.5
	3.5	3.5	3.4	3.3	3.2	3.2	3.0	3.0	2.8	Average 3.6 or 38.5 % to the L.					

## TRACING THE ORIGIN OF THE OWARI VARIETY AND THE HISTORY OF ITS POPULARITY

The discovery of the Owari variety is credited to Inosuke SHIRAKUSA, an active nurseryman of Yamataki-mura, Senhoku-gun, Ôsaka-fu. He traveled in Owari Province as early as 1877, and saw the beautiful young plants of the Satsuma in this district looking considerably better than those of Ikeda village with which he was familiar. He bought 5000 trees that year, and first won recognition by the sympathetic help of Mr. YAMADA, a village magistrate in Idzumi Province. In 1885, another introduction of nursery plants from Owari province was made by Gihei IDE, of the same village, into the province of Idzumi, and these plants came into bearing in Yamataki village, to the perfect astonishment of the villagers. Since 1890, an active business of buying plants from Owari Province started, especially through Mr. Shôemon KAWAKAMI, a well known grower. Mr. MORI, supported by the County Superintendent, planted 1200 trees in 1896 through the introduction of IDE, and the success of this planting made Owari plants exceedingly popular among Ôsaka growers. SHIRAKUSA also devoted himself to the extending of the market of the Owari nursery plants by convincing the growers of the difference in the habit of the tree and the character of the fruits from the Ikeda plants then used. His introduction of an enormous number of one-year old grafts from Aichi Prefecture into Ôsaka-fu, encouraged the nurseries of Owari Province a great deal, and many big nurseries steadily developed, shipping over 500,000 plants every year since about 1900. SHIRAKUSA and other nurserymen in Idzumi Province planted these introduced trees another year under heavy fertilizing. Big fine nursery plants are ready to distribute not only in the same province but to all different places west of Ôsaka. A considerable number of Owari plants were distributed to all western provinces in this way, while the eastern prefectures (Shidzuoka and Kanagawa) have developed lately with rapid growth, based chiefly upon the plants distributed directly from the Owari nurseries.

Mr. Koisaburô YAGI, the biggest Citrus nurseryman in Owari Province, shipping 300 tons of plants every year, gave the information that

the origin of these plants is quite unknown, but up until 1887 many big Satsuma trees were growing there under the name Tômikan or Rifujin, and were all blown down by a heavy storm about this time. Later on, propagation was based upon budwoods taken from the nursery rows. After long experience, he is convinced that the thorn-bearing habit of the first year graft is the safest mark of the variety, and this theory was faithfully followed by his propagators, and thus he won popularity. Although bud sticks of different origin were repeatedly introduced from other provinces, he and his followers kept to a strict selection based upon this particular character, and always kept clean of other varieties. Before the Citrus scab and the leaf-miner were introduced into this region, the young plants of the true Owari variety looked entirely different from other varieties occasionally introduced, by having large, deep-colored, hanging leaves and thick branches with elongated nodes. Before SHIRAKUSA began to handle a bulk of the nursery plants, scions were grafted on very long-rooted trifoliate stock, and the tip of the stock root was often coiled around the crown and fastened to it. This practice was abandoned by SHIRAKUSA's advice and the roots were cut short. Many economical devices were planned in raising the grafts, which resulted in very close planting not seen at any other places. It is remarkable that all of the first year grafts are raised at a distance of 5.6 cm. apart, and five rows at the same distance make a strip of raised bed, running parallel with others, with a deep valley of 37.5 cm. width between them. In this way, 1,544,740 first year grafts can be obtained from 1 hectare of ground. They are transplanted in the second year to a distance of about 30 cm. apart, forming rows 35 cm. apart, and leaving a valley of 46-52 cm. width between the beds. During the winter time, all plants are forced down, one covering the other alternately, until they reach the ground and are covered by straw mats to protect them from cold. Veneer crown grafting is practiced in May or August, with an expectation of about 5% dropping, and heavy fertilizing with fish-cake and bean-cake mixture is applied twice a year. Such a very intensive method of raising young grafts, associated with the strict selection of the budwoods, brought

a large profit to the nurserymen of Owari Province, thus bringing about the rapid growth of the nursery industry of the district.

Identity of the Owari variety with the "Ikiriki" of Nagasaki Prefecture was later made by the author, an account of which will be given later.

### **FIRST DISCOVERY OF THE BUD-VARIATION ORIGIN OF EARLY MATURING SATSUMA**

In the spring of 1918, Dr. W. T. SWINGLE, of the U. S. Department of Agriculture, was informed by Dr. Tetsuya ONDA, former director of the Imperial Horticultural Experiment Station at Okitsu, about the existence of a plant bearing a single branch with remarkably early maturing fruits. At the request of Dr. SWINGLE, three fruits borne on the branch in question were sent to the writer in November, 1918, together with three other fruits of the ordinary Wase variety raised at the Station, for the purpose of comparison. The original tree was found by one of the assistants of the Station in Asahata-mura, Abe-gun, Shidzuoka-ken, and it was confirmed that only one branch bears these particularly early-ripening fruits.

The samples of the variant received on Nov. 16 were nearly mature, but were still light in color and a few green spots were remaining on the surface. The Wase fruits sent together were better colored and in full maturity. These two kinds of fruit of nearly similar appearance were equally tall, depressed-globose, very smooth and polished, with remarkably large-sized oil cell dots. Closer examination showed some difference:—the Wase fruits were rectangular but somewhat flat and slightly obconical, while the fruits from Asahata were taller, and looked very much like large, smooth Ikeda fruits occasionally found in Alabama. The calyx of the Asahata fruits lacked the broadened disk ring, while such characterizes the Wase fruit. In halving the fruits, both showed thin rind, a big amount of pulp, and small central column, but the Asahata fruit displayed a considerably thick segment wall, and a lighter colored pulp. The pulp vesicles were very coarse in both samples, but

those of the Asahata fruits showed a strong tendency to become dry and hard. In tasting the pulp, a big difference was noticed:—the Wase was very rich in flavor and melting, while the other was insipid and raggy. The detailed comparison is given in Table 15.

The leaves, sent together with the fruit, showed that they are very similar to Ikeda, having a narrowed base, a small outline, and being much crowded and somewhat deformed. Although no information was available at the time, it was preliminarily concluded that this new type, if it was really a bud-sport, must have come from an Ikeda tree. No economic value was credited to this new type, because it was far inferior to the commercial Wase fruits. The record of the original plant was not given at this time, but it became clear afterwards, and was reported under the name "Hozaki Wase". This discovery of possible bud-sport origin of fruits extremely near the Wase variety, first gave a strong suggestion of the possibility of the occurrence of similar bud-sports worthy of consideration, and of the successful interpretation of the origin of the Wase variety.

TABLE 15.

COMPARISON OF FRUITS OF THE WASE (NOS. 61-63) AND FRUITS COLLECTED FROM A BUD-SPORT BRANCH FOUND IN ASAHATA-MURA, SHIDZUOKA-KEN (NOS. 71-73)

No.	Girth	Diameter	Height	Transverse section				
				No. Segm'ts.	Rind	Centr. Col.	Seed	Quality
	cm.	cm.	cm.		mm.	mm.		
61	24.2	7.4 × 7.1	5.65	9	2.5-4.0	10 × 13	0	excellent
62	22.1	6.9 × 6.8	5.10	11	2.5-3.5	16 × 15	0	excellent
63	20.5	6.4 × 6.4	4.8		(sent to Dr. SWINGLE)			
71	22.2	7.1 × 6.8	5.4	10	3.0-3.5	13 × 13	0	insipid
72	19.7	6.1 × 6.1	5.0	9	2.5-3.0	12 × 11	0	insipid
73	19.8	6.25 × 6.05	5.0		(sent to Dr. SWINGLE)			

## PRELIMINARY OBSERVATION OF FRUITS FROM THE IKIRIKI REGION

It was one of the most important problems to determine whether the Ikiriki is an independent variety and worthy to plant, or not. Prior to this time, Prof. ONDA advanced his opinion about the existence of at least four varieties of Satsuma, i. e., Ikeda\*, Owari\*\*, Ikiriki, and Wase<sup>(91)</sup>. He gave only a few accounts about Ikiriki, mentioning that it has a large size, round shape, rich flavor, and is not beautiful in appearance. He probably means that the fruit is not attractive due to its deeply pitted, rough skin caused by customary overfertilization.

On a visit to the Nagasaki region in December, 1918, the writer found that there are two distinct kinds of Satsuma orange growing in Ikiriki and the adjacent region, one having typically large and conical fruits and the other smaller and comparatively round ones. The typical Ikiriki fruit has a deep basal depression with irregular grooves radiating from the calyx end, which is surrounded by a flat portion and occasionally surrounded by a sharp ring, as frequently seen in Wase fruits. It has generally a somewhat conical outline, large size, deep colored rind tending to become tenacious and is ready to shrivel. Curiously, the depression of the apex of the fruit is not so pronounced as in the ordinary Owari fruit. The round type is considered to be identical with the Zairai previously reported. In this type of fruit, both ends are not much depressed, the fruit is tight skinned and the oil cell dots are mostly convex. Further comparison of both types will be seen in Table 16.

TABLE 16.

MEASUREMENT OF SATSUMA FRUITS OF TYPICAL IKIRIKI AND OF ROUND  
TYPE, BOTH MATERIALS COLLECTED FROM NAGASAKI  
AGRICULTURAL EXPERIMENT STATION

No. of fruits examined	Av. girth	Av. diam.	Av. height	Transverse section				
				No. segm'ts.	Rind	Centr.	Seed	Quality
<i>Ikiriki</i> 2	cm. 22.7	cm. 7.15	4.83	11	mm. 2-3.5	mm. 14.0	6***	good
<i>Round</i> 3	18.2	5.79	4.62	9-12	2.5-4	11.7	3****	good

\* ONDA calls it "Kishû-kei" or Strain of Kishû (Kii Province).

\*\* He also calls it "Kairyô Owari-kei" or improved strain of Owari.

\*\*\*One fruit seedless, the other contained 6 seeds.

\*\*\*\*One fruit contained 1 seed, two other fruits contained 3 seeds each.

The D/H index of the former (Ikiriki) is 1.48, while that of the latter (round) is 1.25, showing a big contrast. The individual trees yielding these fruits were studied statistically in later years.

## COMPARISON OF OWARI AND ZAIRAI IN FUKUOKA PREFECTURE

Comparison was made to confirm the difference existing between Owari and Zairai varieties in Fukuoka Prefecture, the latter being abundantly cultivated in this prefecture. There is only a single plantation of the Owari variety of distinct origin found in the producing center of this region. The fruits from this orchard showed a large difference from those of the commonly cultivated Zairai. The Owari fruits were all flat and deeply depressed at the apex, and always somewhat conical in outline. The calyx of these fruits was always large and surrounded by a depressed area. The navel marking was always prominent. The Zairai fruits, picked from the oldest dying tree mentioned before, were not typical, due to the poor condition of the tree. They were somewhat pear-shaped, not much depressed at the styler end, and the flavor had considerably deteriorated. Fruits from the adjacent tree of about 60 to 70 years of age, were collected, although no typical fruits were found on the tree. These samples were sufficient to show a considerable difference from the Owari fruits and the figures giving the difference are given in Table 17.

TABLE 17.  
COMPARISON OF SATSUMA FRUITS OF THE OWARI AND THE  
ZAIRAI FROM FUKUOKA PREFECTURE

No. of fruits examined	Av. girth	Av. diam.	Av. height	Transverse section				
				No. segm'ts.	Rind	Centr.	Seed	Quality
<i>Owari</i>	3	cm 19.3	cm. 6.07	cm 3.9	10-13	mm 2.5-3.5	mm. 15.0	0-1 excellent
<i>Zairai</i> (Oldest tree in Fuku- tomi)	5	19.5	6.03	4.9	9-11	2.0-3.5	12.3	2-9 poor
<i>Zairai</i> (Adjacent old tree of the above)	4	18.2	5.71	4.25	9-12	2.0-3.5	10.9	0-6 very poor

D/H index of the Owari fruits is 1.56, while that of the Zairai tree is 1.23 and 1.32 for each sample.

### PRELIMINARY INVESTIGATION OF THE HIRA VARIETY AT TACHIMA

In October, 1919, the village of Tachima in Shikoku Island was visited to investigate the Hira variety named in 1912. This particular variety was possibly originated there, and a very old tree apparently living over 100 years was discovered. It is unquestionable that the Satsuma orange first reached this part of the island from the province of Bungo of Kyûshû Island, just across the channel, but there is an unconfirmed record mentioning that it came from Tosa, another province of Shikoku Island. The largest tree found, which died the next year from an unknown cause, looked very poor in condition, but still was fruiting. The plant had a spread of 7.25 m. by 4.35 m. and was 4.2 m. high. The main trunk was divided into 5 major branches at the bottom, each of them measuring around the base 72 cm., 59 cm., 62 cm., 38 cm., and 36 cm., respectively, at the distance of 30 cm. from the ground. The leaves looked considerably longer and narrower than the average Satsuma leaves, having an acutely pointed apex, a narrowed base and a concave marginal line at the base. There were about 150 fruits on the tree, all looking considerably flat. It was told by Mr. Kingo KAGAYAMA, the owner of the tree, that this plant was bearing about 4000 fruits every year around 1877. The measurement of some of the fruits borne on this tree is given in Table 18. Many plants have been distributed, which have this tree as the source of the scion. They were propagated mostly at Ikeda, where the scions are received from the village. The grafted plants are sent back to the village and they are divided among the growers. Many Ikeda plants were also seen in this village, which had been introduced from time to time from Ikeda since 1865. The Owari plants occasionally seen in the village came from Ôsaka-fu, since about 1890. The comparative figures of the measurement of these three varieties of Satsuma orange are also seen in Table 18. The local growers prefer



the Hira first, Owari next, and Ikeda last. It is said that the plants from Tanushimaru (Zairai) was once introduced into this village, but were soon rejected as being inferior to the others.

TABLE 18.

MEASUREMENT OF SATSUMA FRUITS OF DIFFERENT VARIETIES  
COLLECTED AT TACHIMA, EHIME-KEN, JAPAN

No. of fruits examined		Av. girth	Av. diam.	Av. height	D/H index	Transverse section				
						No. segm'ts.	Rind	Centr.	Seed	Quality
<i>Ikeda</i> (Quite immature, not attaining full size)	3	cm. 15.9	cm. 5.09	cm. 4.07	1.25	10-11	mm. 2-3.5	mm. 8.5	0-1	subacid
<i>Owari</i> (Fully mature, deci- dedly conical in shape)	2	19.4	6.10	4.25	1.39	10-11	2-3	12.0	0	excellent
<i>Hira</i> (1) From the oldest tree of Kingo KAGA- YAMA (well-colored but abnormal)	5	19.1	6.02	4.11	1.46	9-11	2-3.5	11.5	0	medium
(2) Population from various trees from KAGAYAMA'S orchard	3	20.4	6.35	4.50	1.40	9-11	2-3	11.1	0	good
(3) From a young tree about 13 years old, from Tsuneki- chi YAMAGUCHI'S or- chard	3	20.2	6.34	4.41	1.44	10-12	1.5-2.5	12.5	0	good
(4) From a single branch of a tree in Sôichi YAKUSHIJI'S orchard	14	18.8	5.88	4.04	1.45	10-14	1.5-3.5	14.6	0-1*	good

\* 1 seed contained only in one fruit.

The difference between the Owari and the Hira varieties lies not only in the absolute flatness of the fruit, but particularly in the flatness of both ends, which are gradually and broadly shallow-depressed. The depression is, however, quite inconspicuous at the early stage of maturity. In Owari fruits the depression at the apex is more distinct from the early time of coloring, but the concavity of the base does not become very conspicuous until the maturity is greatly advanced. It first com-

mences as a shallow depression around the calyx. It is also noticed that the area of both sides nearest to the apex is more projecting in Owari than in Hira. The rind has a very much smoother texture in Hira, and its oil cell dots are larger and distinctly farther apart. The navel marking is present in both Owari and Hira. The Hira fruit matures at nearly the same time as the Owari does, but the season is much more advanced than in Ikeda. It is better looking than other kinds of Satsuma, and is very much fitted for exhibition fruit. Commercial shipment of the fruit is very successful owing to its attractive appearance, but bruise is rather frequent during transportation, due to the brittleness of the rind and the turgid surface. The leaf of the Hira is quite long and sharp pointed, as mentioned before. It seems to be more susceptible to Greasy Spot disease, caused by *Bacterium flavomaculans* HORI, than any other varieties, and this disease was so destructive that once the cultivation of *Citrus* was almost abandoned, due to the severe damage caused by it. It was also later learned that the growth of the wood after grafting is very slow, making nursery practice rather difficult. This may be the reason why the villagers do not propagate themselves but leave the task to the trained propagator of Ikeda district. This variety was perhaps derived from the mother type of Owari, possibly originated in the northwestern part of Kyûshû Island.

### NEW METHOD DEVELOPED IN INVESTIGATING VARIETY AND INDIVIDUALITY DIFFERENCES

From the studies carried out up to this time, the difference of varieties of the Satsuma orange became very clear. It is almost sufficient to say that the investigation of the Satsuma orange, if it is conducted merely for the purpose of making distinctions in variety, must cease at this time. During the course of the study, however, it was noticed that certain individual trees are showing better characters than other individuals of the same variety planted under the same conditions. It is considered that such individuals must be sought to confirm that they are really and constantly better individuals. Since the purpose of investi-

gation of the Satsuma orange principally lies in the discovery of better types of commercial value, the work went on. It was, therefore, planned to employ the statistical method in sampling the materials for the future studies, and it was aimed to make the difference of individuality more appreciable. By the statistical method is meant primarily an indication of the characters by number, and the employment of as many characters as possible. It is not the purpose of this study to carry on any work on statistics, so that the unnecessary calculation of the variation coefficient and the probable error has been entirely omitted.

As to the sampling, the previous method was considered unsatisfactory. The ordinary method in making any pomological study is to collect samples quite at random from any tree growing in the orchard without making any choice. This unconscious kind of pick generally tends to bring fruits larger than the average, and the dimensions of these fruits do not correctly represent the mean. Many characters associated with large size, such as navel opening, taste, thickness of the rind, and so on, also move from the true average. To avoid this, the ordinary method must not be taken. Even when the character of the tree is quite well known, and no matter how well the author is acquainted with the individual tree, it is, even so, very difficult to distinguish the average differences merely by sight. It is of the first importance to choose the proper tree. It may be necessary to go around the entire orchard or the entire locality to find the representative individual from which the sample should be taken. If such a tree is located, all possible information about the origin and the history of the plant must be obtained, besides a close investigation of the condition of the orchard, management, fertilization practice, and so on must be made. Sample fruits are then picked from the individual at a desirable time, with precaution not to give any injury to the surface of the fruit, as well as to the button. If it is possible, the entire crop of the tree is to be taken for the purpose of making measurements. If such is impracticable, as it requires too much labor, the pick is made from a representative branch carefully chosen. Such branch must bear a proper amount of the crop and represent the average of the total crop of the tree

as nearly as possible. All fruits must be picked from such a branch, not a single fruit being left on it. One must be very careful not to mix the samples of different trees or of different branches, because such a mixture means nothing for the study of individuality. It is desirable to have at least 200 fruits for each lot, unless time and labor does not permit the measurements of so many to be taken. Each fruit taken for the sample must be studied as soon as possible, but it is often true that a delay of study is inevitable. In such a case the outside measurement and especially the weight of the fruit must be taken immediately. It is the common practice, when the sample fruits are received, to arrange them roughly according to their size and number them consecutively. Such numbers must exist only in a single series: the repetition of numbers by lots will cause serious mistakes by accidental mixing. As soon as the sample is ready for measurement, the general description of the lot is to be written down. Such description independently taken without consulting the statistical figures, will be very helpful in grasping the most characteristic point of the lot in comparison with others. Similar descriptions are also taken when the sample fruits are halved. It was also experienced later that a selection of about a dozen fruits is very helpful in taking such a note. For this purpose, the selected fruits must consist of the largest and the smallest, and also the intermediate ones showing different shapes and intermediate sizes. All of these selected pieces are to be sketched, showing an exact side view of each fruit. The largest members among these pieces may be photographed from the side and after they are halved. The measurements and records of all fruits are to be taken according to the numbered order after each item listed below:

- (1) Girth in cm.
- (2) Height in cm. (maximum height in asymmetric fruit)
- (3) Weight in gm.
- (4) Shape of calyx.
- (5) Maximum diameter of calyx in mm.
- (6) Character of stem-end, with special reference to its depression.
- (7) Number of radial grooves from the base, if present.

- (8) Navel marking.
- (9) Character of styler end, with special reference to its depression.
- (10) Areola marking around the styler end.
- (11) Presence or absence of oil cell dots around the styler end.
- (12) Flatness in exact side view.
- (13) Smoothness.
- (14) Color of fruit.
- (15) Existence of green spots.
- (16) Bruise, insect and disease infections.
- (17) Number of segments.
- (18) Maximum and minimum thickness of rind in mm.
- (19) Maximum and minimum diameter of central column in mm.
- (20) Number of seeds.
- (21) Relative thickness of rind in terms of the size of fruit.
- (22) Thickness of segment wall.
- (23) Color of pulp.
- (24) Relative size of the central column in terms of the size of fruit.
- (25) Amount of pith.
- (26) Quality of pulp, with special reference to the amount of acid.
- (27) Puffiness of rind.

Among these, there are several items of a qualitative nature, rather than quantitative. These must be recorded by simple marks clear enough and quick enough to be written down. In tabulating these marks, one reduces them to simple class numbers to which frequency figures can easily be brought together. These class numbers should not be used at the time of recording, because it is psychologically impossible to reduce the quality into absolute numbers correctly and quickly. The explanation of the marks and their corresponding class numbers used in this work is given in the following lines. Numbers in parentheses correspond to those given before.

- (4) Shape of Calyx: There are three classes showing the different shapes of calyx.
  - 1. Marked "e", class No. 1, normal calyx; lobes well marked, elongated-triangular, and fairly long.

2. Marked "t", class No. 2, abnormal calyx; lobes not well developed, low-triangular, and very short. Also designated as "Fruits with undeveloped calyx lobes".
3. Marked "E", class No. 3, abnormal calyx; lobes, or a few of them, considerably elongated and narrowed. Also designated as "Fruits with long narrow calyx lobes".

(6) Character of stem-end.

A. Depression around the calyx: There are three fundamental classes to show the nature, or sort of, depression.

1. Marked "o", class No. 1, sinuate stem-end; the area around the calyx abruptly depressed to a small extent. Also designated as "Sinuate based fruit".
2. Marked "○", class No. 2, normal stem-end; the area around the calyx gradually, broadly, and shallowly depressed.
3. Marked "⊙", class No. 3, double-ringed stem-end; the area around the calyx has sharp circular grooves, besides the ring lining the disk.

B. Depth of the depression: Three classes of the extent of the depression are marked in the following way. When such mark is absent, the extent of depression is smallest or as shallow as possible.

1. Marked ".", (a dot in the circular mark given above), class No. 1, slightly more depressed than normal (simple circle).
2. Marked "/", (an oblique line across the circle but enclosed within it), class No. 2, still more depressed than above.
3. Marked "⌋", (an oblique line penetrating the circle), class No. 3, most depressed in a considerable way.

(8) Navel marking.

1. Marked "+", class No. 1, naveled fruit, or the navel marking is well developed. Also designated as "Naveled fruit".
2. Marked "-", class No. 2, navel distinctly closed.
3. Marked "(-)", class No. 3, navel very minutely open, looking almost closed. It is generally counted as closed.

(9) Character of stylar end: Generally four classes are made. Sometimes two additional classes are also designated.

1. Marked "d", class No. 1, conspicuously depressed, broadly and deeply concave.
  - 1(1). Often marked "D", most considerably depressed. This generally added to the above 1.
  - 1(2). Rarely marked "δ", most conspicuously depressed with the clear marking around the margin; the depression commences abruptly from the areola. This is also added to 1 in calculation.
2. Marked "N", class No. 2, broadly but not deeply depressed, a type of normal depression.
3. Marked "n", class No. 3, narrowly and shallowly depressed, another type of normal depression.

4. Marked "f", class No. 4, not depressed; the end is simply flat, rarely a trifle convex.
- (10) Areola marking around the stylar end. Areola is a circular marking at a short distance from the stylar point of the fruit, composed of the presence of fovea pitting or the absence of the oil cell dots. If it is present, there are three classes.
1. Marked "r", class No. 1, when the concave dots form the areola.
  2. Marked "-r", class No. 2, when it is marked by the absence of dots.
  3. Marked "R", when series of large fovea and naked area alternatively forming a very conspicuous areola. This is generally added to the first, when count is made. Most frequently only areolated fruits are counted when the final tabulation is made.
- (11) Presence or absence of oil cell dots around the stylar end. Three classes are noted. Often designated as "Apical dots".
1. Marked "o", class No. 1, dots are wanting around the stylar point. Also denoted as "Fruits with naked apex".
  2. Marked "1", class No. 2, a few dots are present around the stylar point. The number is more reduced than those on side.
  3. Marked "e", class No. 3, dots reach to the stylar point, without the number being reduced. Both 2 and 3 are generally tabulated together.
- (12) Flatness in exact side view. Five classes are always given, as follows:
1. Marked "f", class No. 1, flat. D/H index is approximately above 1.35.
  2. Marked "mf", class No. 2, medium flat. D/H index is approximately between 1.35 and 1.30.
  3. Marked "m", class No. 3, medium. D/H index is approximately between 1.30 and 1.25.
  4. Marked "mh", class No. 4, medium high. D/H index is approximately between 1.25 and 1.20.
  5. Marked "h", class No. 5, high. D/H index is approximately below 1.20.
- (13) Smoothness. Divided into 5 classes.
1. Marked "sm", class No. 1, smooth. Surface is polished, oil cell dots are flat, neither convex nor concave, otherwise a trifle convex.
  2. Marked "ev", class No. 2, even, not polished but the surface is flat, oil cell dots inconspicuously convex or very slightly concave. When convex dots predominate over the concave ones, it is often marked "dev", and when it is just the opposite, "pev" is frequently given. This means "dot-even" and "pit-even", respectively.
  3. Marked "h", class No. 3, harsh. The surface is not even, but not conspicuously rough, just being intermediate. Oil cell dots are both convex and concave, intermixed. According to the amount of the convex and concave dots, "dh" and "ph" are also designated.
  4. Marked "r", class No. 4, rough. The surface is roughly pitted. Rarely roughness is caused by very prominent convex dots: In that case "dr" is used to distinguish.

5. Marked "R", class No. 5, very rough. The surface is very roughly pitted. When the roughness is caused by extra-prominent convex dots, "dR" is given to distinguish it from ordinary pit-rough.
- (14) Color of fruits. The color of fruit is classed into five degrees as below: Since it is only concerned with the condition of the material received, the color is not tabulated in the final report.
1. Marked "or", class No. 1, orange color.
  2. Marked "o", class No. 2, light orange color.
  3. Marked "yo", class No. 3, yellowish orange color.
  4. Marked "y", class No. 4, yellow color.
  5. Marked "ly", class No. 5, light yellow color.
- (15) Existence of green spots. This is marked five different signs, irrespective of the ground color.
1. Marked ":", class No. 1, with inconspicuous green patches.
  2. Marked "/", class No. 2, green area about  $\frac{1}{5}$  of the whole fruit.
  3. Marked "x", class No. 3, green area about  $\frac{1}{3}$  of the whole fruit.
  4. Marked "✕", class No. 4, green area about  $\frac{2}{3}$  of the whole fruit.
  5. Marked "✱", class No. 5, green area all over and no yellow ground color is exposed.
- (16) All kinds of bruises and wounds are noted. Damages received by infections of harmful organisms are also listed. These are: (1) Rots (Stem-end rot, blue mould, *Botrytis* rot, black rot, etc.); (2) Disease spots (sour scab, melanose, sooty mould, etc.); (3) Insects (scale insects, thrips, rust mite, red spider, etc.). Rusty and russet fruits are common due to slight infections of scab or mite.
- (21) Relative thickness of rind in terms of size of fruit. This is generally called "thinness of the rind". There are five classes according to the increase of thickness.
1. Marked "t", class No. 1, thin.
  2. Marked "mt", class No. 2, medium thin.
  3. Marked "m", class No. 3, medium.
  4. Marked "mT", class No. 4, medium thick.
  5. Marked "T", class No. 5, thick.
- The medium class is about the normal thickness, i. e., about  $\frac{1}{12}$  of the diameter of the fruit.
- (22) Thickness of the segment wall. This is also a relative thickness, and is classed in 5 groups, using the same mark as is used above in (21). This is also called "Thinness of segment wall."
- (23) Color of pulp. Five classes are given.
1. Marked "d", class No. 1, deep colored (Orange chrome in RIDGWAY's Color Standards)
  2. Marked "md", class No. 2, medium deep colored.



3. Marked "m", class No. 3, medium in color (Orange in RIDGWAY's Color Standards).
  4. Marked "ml", class No. 4, medium light in color.
  5. Marked "l", class No. 5, light-colored (Deep Chrome in RIDGWAY's Color Standards).
- (24) Relative size of the central column in terms of the size of fruit. Simply marked "Size of central column". Five classes are given.
1. Marked "L", class No. 1, large.
  2. Marked "mL", class No. 2, medium large.
  3. Marked "m", class No. 3, medium sized. This is about the normal size, well proportioned to the size of the fruit, being about  $\frac{1}{4}$  of the diameter of the fruit.
  4. Marked "ms", class No. 4, medium small.
  5. Marked "s", class No. 5, small.
- (25) Amount of pith. The relative quantity of white pith in the central column is divided into 5 classes.
1. Marked "M", class No. 1, much. Pith nearly covering the entire area of central column.
  2. Marked "mM", class No. 2, medium abundant. Pith covering nearly  $\frac{2}{3}$  of the central column.
  3. Marked "m", class No. 3, medium. Pith covering less than  $\frac{1}{4}$  of the central column.
  4. Marked "ml", class No. 4, medium little. Pith covering less than  $\frac{1}{6}$  of the central column.
  5. Marked "l", class No. 5, little. Pith is attached to the inner end of the segment, so that the central column appears almost hollow.
- (26) Quality of pulp, with special reference to the amount of acid. Five classes are given.
1. Marked "g", class No. 1, good. Taste sweet; and very little acid.
  2. Marked "mg", class No. 2, medium good. Taste sweet; a little amount of acid.
  3. Marked "m", class No. 3, medium. Sweetness is decidedly low, and acidity is also not stronger than above, therefore, insipid fruits are always listed in this class.
  4. Marked "subac", class No. 4, subacid. Acidity is pronounced, while sweetness is low.
  5. Marked "acid" class No. 5, acid. Almost no sweetness is tasted.
- (27) Puffiness of rind. This shows the degree of maturity, or whether the time of picking is proper or not. Three classes are given. This is generally not tabulated in the final report.
1. Marked "B", class No. 1, baggy. Rind is entirely or almost entirely free from the pulp ball.
  2. Marked "b", class No. 2, slightly baggy. Detached area of the rind from the pulp ball does not exceed  $\frac{1}{2}$  of the whole area.
  3. Marked " $\pm b$ ", class No. 3, very slightly baggy. Only a few segments are free from the rind.

## BOOK IV



## INDIVIDUALITY AND SELECTION PROBLEM IN THE SATSUMA ORANGE

### SCOPE OF THE WORK CONDUCTED DURING 1919 AND 1921

The chief aim of the work conducted during the period of 1919 and 1921, in Japan and America, was to find out if there is any individual difference within the varieties of the Satsuma orange studied up to this time, and the significance of selecting choice individuals for propagation. Problems which had not been settled during the last season were also taken up for solution. Such problems were, the identity of Ikiriki, Kogakei, and a certain American strain. In carrying out the program, the statistical method described in the preceding chapter was employed, and extensive field studies and the measurement of fruits were made. In the winter of 1919, the prefectures of Nagasaki, Fukuoka, Ehime, Hiroshima, and Kagoshima, in Japan, were visited, and 24 individual trees within the varieties of Zairai, Ikeda, Owari, and the so-called Ikiriki, were chosen for study. The materials obtained in this year are listed in Table. 19.

**TABLE 19.**

LIST OF MATERIALS EMPLOYED FOR INDIVIDUALITY INVESTIGATIONS OF  
THE SATSUMA ORANGE IN JAPAN, DURING THE YEAR 1919

Lot No.	Names of Grower	Locality	No. of fruits studied	Grower's identification
1	Prefectural Agric. Experiment Station	Nakagawa, Nagasaki-shi, Nagasaki-ken	626	Kogakei
2	do.	do.	584	Ikiriki
3	do.	do.	467	Ikiriki (round)
4	do.	do.	40	Senshû Kairyô
5	do.	do.	101	Wase (not true)

TABLE 19.—(Continued)

Lot No.	Names of Grower	Locality	No. of fruits studied	Grower's identification
6	TANAKA, Motarō	Maruo, Funatsu-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	588	Ikiriki
7	KOBAYASHI, Kesaki-chi	Higuchi, Yamagawachi-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	47	Owari
8	MIZOMOTO, Kinzō	Tagashira, Funatsu-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	550	Kogakei
9	KAGAYAMA, Kingo	Iiagio, Tachima-mura, Kitauwa-gun, Ehime-ken.	249	Iiira
10	MORIGUCHI, Seisaku	Ōkubo, Funatsu-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	439	Ikeda
11	IARA, Shiroshi	Teshiroyama, Yoshii-chō, Ukihagun, Fukuoka-ken	474	Owari
12	OGATA, Kenzaburō	Matsuda, Funatsu-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	205	Ikeda (wrinkled)
13,15	SUEOKA, Gosaku	Bessō, Minamiadzuchi, Ōchō-mura, Toyota-gun, Hiroshima-ken	147	Ōchō local
14	do.	do.	164	Tsukumi local (small)
16	do.	do.	141	Tsukumi local (large)
17	SHIGENORU, Toranoshin (Kōkwaen)	Yoshino-mura, Kagoshima-gun, Kagoshima-ken	274	Zairai
18	do.	do.	108	Ikiriki
19	SETOGUCHI, Yashirō (Hōkwaen)	Sakamoto, Yoshino-mura, Kagoshima-gun, Kagoshima-ken	507	Owari (wrinkled)
20	do.	do.	270	Ikeda (unproductive)
21	do.	do.	614	Owari
22	GyōTOKU, Getto (Anchōji)	Moribe, Minō-mura, Ukiha-gun, Fukuoka-ken	547	Zairai
23	BUTŌ, Shikatarō	Higuchi, Yamagawachi-gō, Nishisonoki-gun, Nagasaki-ken	101	Kogakei
24	YAKUSHIJI, Sōichi	Nishinotani, Aramaki, Tachima-mura, Kitauwa-gun, Ehime-ken	60	Hira

In the year of 1920, the work was very much extended, covering the prefectures of Ōsaka, Shizuoka, Kanagawa, Wakayama, and Ōita, besides four prefectures visited in the preceding year (Kagoshima was not visited). 43 lots of individual trees\* were investigated, besides 22 lots of Wase reported in the later books. Table 20 gives the list of these materials. The work was most actively carried on in Nagasaki Prefecture, where many attractive problems have developed in connection with variety segregation and the selection of best individuals. Stress was also given to the study of the Hira variety, but the work did not develop much, because standardization work had already been fairly well

\* With one exception, which was a population of 6 fruits.

established in the original locality. A large diversity in individual differences was observed in well distributed varieties like Owari and Ikeda, as was expected. The Zairai variety was found occurring only in a few localities, like Fukuoka, Ôita, and Nagasaki, and seemed to be losing its popularity very rapidly. The origin of the Ikeda variety seemed to be based upon it, but it was stabilized by the exclusion of others. The Owari seemed most popular of all Satsuma varieties, and its future development in planting acreage is expected. Many abnormal types were also discovered during both seasons, such as Wrinkled Ikeda, Wrinkled Owari, Unproductive Ikeda, Willow-leaf Ikeda, Round-fruited Zairai, and so on. Many associated problems in connection with the individuality study were also discussed. Besides the materials listed above, a few later observations were used in making out the data discussed in the present book. No active work has been conducted in Japan upon the objects treated here in the following years, since energy has been concentrated on the problem of bud variation in Wase Satsumas.

TABLE 20.

LIST OF MATERIALS EMPLOYED FOR INDIVIDUALITY INVESTIGATIONS  
OF THE SATSUMA ORANGE IN JAPAN, DURING  
THE YEAR 1920

Lot No.	Names of grower	Locality	No. of fruits studied	Grower's identification
25	KAWAKAMI, Shôemon	Uchibata, Yamataki-mura, Senhokugun, Ôsaka-fu	99	Owari (oldest)
26	do.	do.	150	Owari (Yuzu stock)
27	Nagasaki Agr. Exp. Station	Nakagawa-chô, Nagasaki-shi, Nagasaki-ken	1	Ikiriki
28	KITAURA, Ihei	Kashima-gô, Ikiriki-mura, Nishisonokigun, Nagasaki-ken	50	Ikiriki (Kabusu stock)
29,30	MATSUO, Shintarô	Sase-gô, Ikiriki-mura, Nishisonokigun, Nagasaki-ken	164	Ikiriki
31,2	HIRAKIDA, Kunisaku	Kashima-gô, Ikiriki-mura, Nishisonokigun, Nagasaki-ken	101	Ikiriki (flat)
33	TANAKA, Motarô	Maruo, Funatsu-gô, Ikiriki-mura, Nishisonokigun, Nagasaki-ken	50	Ikiriki (near Owari)
34	MIZOMOTO, Kinzô	Tagashira, Funatsu-gô, Ikiriki-mura, Nishisonokigun, Nagasaki-ken	19	Ikiriki (near Owari)
35	do.	do.	1	do. (variegated)
36	do.	do.	90	Owari (round)

TABLE 20.—(Continued)

Lot No.	Names of grower	Locality	No. of fruits studied	Grower's identification
37	MIZOMOTO, Kinzō	Tagashira, Funatsu-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	29	Owari (round)
38	KAGAYAMA, Kingo	Hagio, Tachima-mura, Kitauwa-gun, Ehime-ken	97	Hira (near Owari)
39	YAKUSHIJI, Tokutarō	Yashiki, Tachima-mura, Kitauwa-gun, Ehime-ken	720	Zairai
40	KAWANO, Tōyōji	Kusugaseko, Kuratomi, Aoe-mura, Kitaamabe-gun, Ōita-ken	497	Zairai
41	TOKIWA, Sakujirō	Ozaki, Kajiya, Yoshihama-mura, Ashigarashimo-gun, Kanagawa-ken	141	Owari
42,43	MATSUMI, Kinzō	Tegoshi, Ōsada-mura, Abe-gun, Shidzuoka-ken	50	Owari
44	do.	do.	6	Owari (sport branch)
45	SUZUKI, Teizō	Mariko, Ōsada-mura, Abe-gun, Shidzuoka-ken	21	Owari
46	KATAHIRA, Kurozaemon	Sugiyama, Iwara-mura, Iwara-gun, Shidzuoka-ken	117	Owari
47	AKASAKA, Kahei	Hironoyama, Yamataki-mura, Senhoku-gun, Ōsaka-fu	186	Owari
48	MINAMI, Torajirō	Shirooka, Yamataki-mura, Senhoku-gun, Ōsaka-fu	406	Ikeda
49,50	YAKUSHIJI, Sōichi	Aramaki, Tachima-mura, Kitauwa-gun, Ehime-ken	356	Hira
51	do.	do.	229	Hira
52,53	KAWAKAMI, Shōemon	Yamatuki-mura, Senhoku-gun, Ōsaka-fu	203	Ikeda
54	GORYŌDA, Monza-burō	Adachi, Ōchō-mura, Toyoda-gun, Hiroshima-ken	93	Ikeda
55,56	MORIGUCHI, Sesiaku	Ōkubo, Funatsu-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	253	Ikeda
57	Wakayama Agr. Exp. Station	Inokuchi, Tadono-mura, Arita-gun, Wakayama-ken	43	Ikeda
58	do.	do.	13	Ikeda (variegated)
59	do.	do.	59	Ikeda
60	do.	do.	23	Ikeda (variegated)
61	NAKAMURA, Kane-kichi	Yamanoue, Obama-mura, Minamitakaki-gun, Nagasaki-ken	17	Ikeda
62	BURŌ, Shikatarō	Higuchi, Yamagawachi-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	45	Ikeda
63	HIRAKIDA, Kunisaku	Kashima-gō, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken	50	Ikeda
64	KAWANO, Benzō	Kadzuragahata, Aoe-mura, Kitaamabe-gun, Ōita-ken	196	Zairai (round)
63bis	KAWANO, Isokichi	do.	3	Zairai (round)
65	SUGIYAMA, Shigeru	Enokidaira, Iwa-mura, Ashigarashimo-gun, Kanagawa-ken	10	Willow-leaf
66	GORYŌDA, Monza-burō	Adachi, Ōchō-mura, Toyoda-gun, Hiroshima-ken	94	Willow-leaf
67	YAKUSHIJI, Itarō	Ōgawachi, Tachima-mura, Kitauwa-gun, Ehime-ken	40	Willow-leaf
68	NARIKAWA, Sōsuke	Michi, Yasuda-mura, Arita-gun, Wakayama-ken	42	Willow-leaf

TABLE 20.—(Continued)

Lot No.	Names of grower	Locality	No. of fruits studied	Grower's identification
69	TANIGUCHI, Fusaki-chi	Michi, Yasuda-mura, Arita-gun, Wakayama-ken	5	Owari (large fruit)
70	SHINO, Kunitarô	Maegawa, Maeba-mura, Ashigara-shimo gun, Kanagawa-ken	6	Owari, population.

Experiments were conducted also in the United States as a continuation of the work accomplished in Japan. The field observation in the States of Alabama and Mississippi was carried out during the period between Oct. 18 and Nov. 11, 1921. Samples of fruit were collected from representative individuals (Lots 71-90), and were studied in Washington, D. C. The presentation of this data obtained by this investigation is to furnish a sufficient proof of the exact similarity of the varietal characters of the Satsuma orange grown under American conditions, in comparison with those observed in Japan. No intention other than this scientific one is involved in describing the products offered by the growers to assist the author's study.

## FURTHER DIFFERENCES BETWEEN IKIRIKI AND KOGAKEI

Statements have been given about the existence of two distinct types of the Satsuma orange in the Nagasaki region; the Ikiriki and a round type, locally called the "Kogakei". The nomenclature of the latter is taken from the name of the village from which the variety was distributed. Koga village is located in Kitatakaki-gun of Nagasaki Prefecture, and because of its geographical advantage, forestry nurseries have been in existence from an unknown period. Since about 1870, the raising of horticultural plants became gradually active, and the nurserymen found profit in selling ornamental plants to the foreign merchants of Nagasaki, who exported Japanese goods. The trade in Citrus trees was only to fill the local demand at the beginning, and no particular attention was given to the difference of variety or strain. Apparently, nursery plants introduced from Tanushimaru, Fukuoka Prefecture, were sold in a compara-



tively large quantity until about 1892, but these plants gradually lost favor among the local Citrus growers, due to their poor quality. Apparently the characters of the fruits of the Kogakei agree with those of the Zairai of Tanushimaru as stated before, but it was thought necessary to determine whether this is a definite variety or not. Before attacking this problem, it must be shown first that the Kogakei is distinct from the so-called Ikiriki Satsuma. To make this point clear, two plants were chosen in the same orchard of the Nagasaki Prefectural Agricultural Experiment Station at Nakagawa, Nagasaki City, these plants representing the Ikiriki and the Kogakei. They looked very similar in age and vigor, both having been treated equally since they were planted. Details of both trees are given below.

Lot No. 1 of 1919. "Kogakei" Satsuma at the Nakagawa Station, plot No. 19, on a moderate slope, 23 years old in 1919, 2nd tree from east in the 3rd row from the bottom, planted 2 m. away from the others. Moderately large tree, E-W spread 2.6 m., N-S spread 3.8 m., height 2.3 m., branches moderately spreading, branchlets not much drooping and the twigs more or less much twisted, mixed with characteristic upright shoots. Leaves large, hanging, dense and deep-colored, apex gradually pointed, base also narrowed. It is said that the blooming is later than the Ikiriki. The entire crop of the tree was used for study. The average size of the fruits was not very large, they generally were medium in flatness, and among the large members only two fruits were found flat, the rest being taller. Details of the measurements is given in Table 21.\*

Lot No. 2 of 1919. "Ikiriki" Satsuma at Nakagawa Station, plot No. 4, on slope, middle row, 5th tree from east, next to young plant eastward, planted at a distance of 2.3 m. from east, 2.9 m. from west, 2.6 m. from south, and 2.6 m. from north, 14 years old in 1919. Moderately large sized tree, E-W spread 2.9 m., N-S spread 2.5 m., height 2 m., tree of well balanced hemispheric form, branches moderately spreading with round top, appearing somewhat conical in shape. Leaves large, not

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\* PL. II. Fig. 1.

many but dense, broad but pointed at the apex, deep-colored. The fruit is said to have an earlier maturity, beginning at the end of November. The entire crop of the tree was taken for investigation. The average size of the fruits is larger and the shape is considerably more flat than Lot No. 1 (Kogakei). The details of the characters of the fruit can be seen in Table 22.\*

Comparing the figures of these tables, a great difference in the flatness of fruit, number of segments, thinness of the rind, color of pulp, size of central column, and the quality of fruit can be seen. Although the smoothness of the surface and apical dots are very similar, the Kogakei fruits have a more rounded apex and less developed navel marking, it is remarkable that the plants growing very close together receiving the same treatment, show such an appreciable difference in the sweetness of the pulp. The seediness of both lots is due to the mixed planting of seedy species in the surrounding plots.

Comparison in the field revealed that although both trees were grown under very similar conditions, the Ikiriki tree showed a good spread of branches and larger foliage, while the Kogakei showed drooping branches with crowded smaller leaves. The fruits looked similar, as far as the size and shape are concerned, but a more careful comparison showed that the former had a more depressed outline and distinctly larger calyxes. It seemed a characteristic of Ikiriki to have a flattened, not sinuate stem-end, often with long and deep radiating grooves. On the average, the size of the fruit was larger, the peel of a beautiful color, and the navel mark very prominent. The texture of the rind was leathery and durable, not puffy, and tight enough to keep the pulp in a juicy state for a long period, with a maximum degree of sweetness.

In conclusion, the Kogakei and the Ikiriki belong to different varieties. They are really treated differently by the local Citrus growers, everyone being aware that the Kogakei is inferior to the Ikiriki. Further evidence on this account will be given in later chapters.

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\* PL. II, Fig. 2.

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TABLE 21.

MEASUREMENT OF SATSUMA FRUITS RECEIVED AS KOGAKEI FROM NAGASAKI  
 AGR. EXP. STAT. LOT NO. 1 OF 1919. TOTAL NUMBER OF FRUITS, 626

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.91 cm.	4.47 cm.	1.23	—	—	10.50	2.20 mm.	9.76 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	626	—	—	—	—	—	131	20.93%
Sinuate based fruits	613	—	—	—	—	—	574	93.64
Semi-sinuate based fruits	613	—	—	—	—	—	4	0.65
Areolated fruits	626	—	—	—	—	—	70	11.18
Frs. with undeveloped calyx lobes		(not observed)						
Frs. with long narrow calyx lobes								
Fruits containing seeds	626	—	—	—	—	—	343	54.79
Apical depression	625	129 20.64	341 54.56	155 24.80%	—	—	—	—
Apical dots	620	34 54.90	274 44.19	312 50.32%	—	—	—	—
Flatness of fruit	621	2 0.32	208 33.49	379 61.03	32 5.15	0 0%	—	—
Smoothness of fruit	622	56 9.00	238 38.26	242 38.91	58 9.32	28 4.50%	—	—
Thinness of rind	626	358 57.19	155 24.76	56 8.95	29 4.63	28 4.45%	—	—
Thinness of segment wall	624	411 65.97	145 23.24	35 5.63	11 1.75	22 3.53%	—	—
Color of pulp	626	463 73.96	106 16.93	5 0.80	1 0.16	51 8.15%	—	—
Size of central column	624	0 0	1 0.16	216 34.62	193 30.93	214 34.29%	—	—
Quantity of pith	624	19 3.04	127 20.35	293 46.96	139 22.58	44 7.05%	—	—
Quality of pulp	619	61 9.85	165 26.66	221 35.70	139 22.46	33 5.33%	—	—

TABLE 22.

MEASUREMENT OF SATSUMA FRUITS RECEIVED AS IKIRIKI FROM NAGASAKI  
AGR. EXP. STAT. LOT NO. 2 OF 1919. TOTAL NUMBER OF FRUITS, 594

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.69 cm.	4.28 cm.	1.47	—	—	10.63	2.01 mm.	10.97 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	584	—	—	—	—	—	238	% 40.75
Sinuate based fruits	583	—	—	—	—	—	16	2.74
Semi-sinuate based fruits	583	—	—	—	—	—	1	0.17
Areolated fruits	584	—	—	—	—	—	156	26.71
Frs. with undeveloped calyx lobes	101	—	—	—	—	—	35	34.65
Frs. with long narrow calyx lobes	101	—	—	—	—	—	0	0
Fruits containing seeds	584	—	—	—	—	—	389	66.61
Apical depression	578	48 8.30	212 36.68		318 55.02%	—	—	—
Apical dots	580	40 6.90	248 49.66	252 43.45%	—	—	—	—
Flatness of fruit	579	55 9.50	362 62.52	158 27.29	3 0.52	1 0.17%	—	—
Smoothness of fruit	584	58 9.93	217 37.16	194 33.32	90 15.41	25 4.28%	—	—
Thinness of rind	583	473 81.13	87 14.92	13 2.23	7 1.20	3 0.51%	—	—
Thinness of segment wall	584	475 81.34	94 16.10	6 1.03	5 0.86	4 0.68%	—	—
Color of pulp	584	526 90.07	36 6.16	3 0.51	1 0.17	18 3.07%	—	—
Size of central columu	582	0 0	12 2.06	361 62.03	152 26.12	57 9.79%	—	—
Quantity of pith	583	16 2.74	92 15.78	298 51.11	134 22.98	43 7.38%	—	—
Quality of pulp	581	239 41.14	210 36.14	105 18.09	22 3.79	5 0.89%	—	—

## THE IDENTITY OF THE IKIRIKI AND THE OWARI

After an elaborate search in locating Owari trees in Ikiriki village, a small planting of imported trees from Owari Province was found in Mr. KOBAYASHI's nursery at Higuchi, Yamagawachi-gō. This planting consists of a few sample trees of the Owari variety, planted around the nursery for the purpose of demonstrating a variety supposed to be new to the villagers. On account of the discovery that the fruits of this variety are no better than those of Ikiriki, the business in selling these imported nursery plants was abandoned, and these plants were neglected. They looked rather poor in condition when they were found, but it was a great surprise to watch the fruits on the tree, looking so identical to the Ikiriki fruits. Although the owner of the nursery was absent, a critical inquiry was made if he had not planted Ikiriki trees, instead of Owari, to deceive the local growers, previously knowing that the Ikiriki is a better variety than the Owari. This was soon disproved, and it was verified that these plants actually came from the Owari nurseries in 1911. It was later told that each tree had been receiving as fertilizer 20 kin (12 kg.) of bean cake every year and is mulched with cotton seeds once a year. The crop is picked about the early part of December, the coloring being slightly earlier than local varieties. The fruits are sold in Nagasaki and Saseho at 7 yen per 100 kin (11.67 yen per 100 kg.), that being about the same price as other Satsuma fruits. A representative tree, from which the entire crop was picked for study, is described as follows:

Lot No. 7 of 1919. Owari Satsuma at the nursery of Kesakichi KOBAYASHI, Ikiriki village. The tree planted 8 years ago, was 1.74 m. in spread on both directions and 1.74 m. high. Branches few, irregularly stretched, not drooping, rather defoliated and not thrifty. Leaves few, large, broad, yellowish due to malnutrition, and sooty.

Owing to the poor condition of the tree, the fruit was tight-skinned, being not fully expanded, but it was evident that the tendency is to bear flat fruit when the conditions are better. The calyx was typically large with an exception of a few fruits which had undeveloped lobes, and sinuate-based fruits were almost none.

Despite the fact that the trees were receiving very little care, the quality of fruits was far better than those of the Nagasaki Station, which represented the Ikiriki. All other characters, such as thin rind, thin segment wall, comparatively large central column, etc., were identical with the Ikiriki fruit. The measurements of fruits are given in Table 23.\*

In order to verify the view on the identity of the Ikiriki and the Owari, another plant of the Owari, growing in Nagasaki Prefecture, was chosen for comparison. This was a small tree planted at the Nagasaki Agricultural Experiment Station at Nakagawa, under the name "Senshû Kairyô", or "Idzumi Province Improved", and it was obvious that this represented the Owari, which had been imported into Idzumi Province, cared for a year or two, and then distributed to other places, as mentioned before. The characters of the tree are given as below :

Lot No. 4 of 1919. Owari tree (Senshû Kairyô) at Nakagawa Station. Located in plot No. 5 (fertilizer trial), on slope, 3rd tree from east on the lowermost row, planted 2.6 m. away from the others. A small tree, with an E-W spread of 2.75 m., N-S spread 2.75 m., height 1.74 m., branches thick and spreading with weak twigs few in number, forming a round head. Leaves moderately broad, dense, both ends not acute, pointed, deep-colored. A few branches elongated and rather drooping due to the weight of the fruits. The measurements of fruits are given in Table 24.\*\*

The figure shows a great similarity to the fruit of KOBAYASHI's Owari, especially in flatness and smoothness of fruit, apical depression, size of central column, and quality of fruits. This has a still thinner rind and segment wall. By comparison with Table 22 (Ikiriki of Nakagawa Station), a similarity with the Ikiriki fruits will also be noticed, especially in the shape of the fruit, the thinness of the segment wall, the medium-sized central column, and the quality of the fruit. The thinness of the rind is more pronounced in the Ikiriki, and the quantity of the pith is also very slightly more abundant but no appreciable difference is observed in anything else.

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\* PL. II, Fig. 3.

\*\* PL. II, Fig. 4.

TABLE 23.

MEASUREMENT OF SATSUMA FRUITS OF OWARI VARIETY FOUND AT IKIRIKI VILLAGE IN 1919. LOT NO. 7 OF 1919. TOTAL NUMBER OF FRUITS, 47

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.85 cm.	4.72 cm.	1.27	80.85 gm.	—	10.82	2.39 mm.	11.59 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	47	—	—	—	—	—	28	59.57
Sinuate based fruits	45	—	—	—	—	—	2	4.44
Areolated fruits	47	—	—	—	—	—	7	14.89
Frs. with undeveloped calyx lobes	34	—	—	—	—	—	6	17.65
Frs. with long narrow calyx lobes	34	—	—	—	—	—	4	11.77
Fruits containing seeds	47	—	—	—	—	—	6	12.77
Apical depression	46	1 2.17	7 15.22	21 45.65	17 36.96%	—	—	—
Apical dots	46	1 2.17	13 28.26	32 69.57%	—	—	—	—
Flatness of fruit	46	1 2.17	33 71.74	12 26.09	0 0	0 0%	—	—
Smoothness of fruit	46	2 4.35	6 13.04	26 56.52	1 2.17	11 23.91%	—	—
Thinness of rind	44	25 56.82	12 29.27	6 13.62	1 2.27	0 0%	—	—
Thinness of segment wall	44	31 70.45	12 29.55	0 0	0 0	0 0%	—	—
Color of pulp	44	36 81.82	7 10.86	1 2.27	0 0	0 0%	—	—
Size of central column	44	0 0	2 4.55	32 72.72	8 18.18	2 7.71%	—	—
Quantity of pith	44	2 4.55	7 15.91	34 77.27	1 2.27	0 0%	—	—
Quality of pulp	43	20 46.51	14 32.56	6 13.95	2 4.65	1 2.33%	—	—

TABLE 24.

MEASUREMENT OF SATSUMA FRUITS OF OWARI VARIETY FROM NAGASAKI  
AGR. EXP. STAT. LOT NO. 4 OF 1919. TOTAL NUMBER OF FRUITS, 40

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.91 cm.	4.32 cm.	1.47	96.78 gm.	—	10.85	2.40 mm.	11.74 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	40	—	—	—	—	—	13	32.50%
Sinuate based fruits	40	—	—	—	—	—	4	10.00
Semi-sinuate based fruits	40	—	—	—	—	—	14	35.00
Areolated fruits	40	—	—	—	—	—	17	42.50
Frs. with undeveloped calyx lobes		(not observed)						
Frs. with long narrow calyx lobes								
Fruits containing seeds	40	—	—	—	—	—	34	85.00
Apical depression	40	12 30.00	12 30.00	16 40.00%	—	—	—	—
Apical dots	40	5 12.50	21 52.50	14 35.00%	—	—	—	—
Flatness of fruit	40	2 5.00	32 80.00	6 15.00	0 0	0 0%	—	—
Smoothness of fruit	40	0 0	10 25.00	17 42.50	7 17.50	6 15.00%	—	—
Thinness of rind	40	26 65.00	12 30.00	2 5.00	0 0	0 0%	—	—
Thinness of segment wall	40	36 90.00	4 10.00	0 0	0 0	0 0%	—	—
Color of pulp	40	35 87.50	5 12.50	0 0	0 0	0 0%	—	—
Size of central column	40	0 0	1 2.50	24 60.00	7 17.50	8 20.50%	—	—
Quantity of pith	40	0 0	1 2.50	27 67.50	12 30.00	0 0%	—	—
Quality of pulp	40	16 40.00	13 32.50	11 27.50	0 0	0 0%	—	—



The experiment plot where this plant was found was fertilized with 4 kwan (15 kg.) of nitrogen, 2 kwan (7.5 kg.) of phosphoric acid and 4 kwan (15 kg.) of potash.

*Plant of Ikiriki studied in another prefecture*

Before deciding the identity of the Owari and the Ikiriki varieties, another step was taken to compare the Ikiriki plant with the Owari in a place outside of Nagasaki Prefecture. It took some time until this could be accomplished, but after a strenuous search, a proper sized plant of Ikiriki was found in Kagoshima Prefecture. This is a medium-sized tree about 20 years old, located at the Kôkwaen orchard, at Yoshino, in the vicinity of Kagoshima City, formerly belonging to the Prefectural Agricultural Society under the directorship of Mr. Takenori MAEDA, a noted horticulturist. The tree is definitely of Ikiriki origin, and was sent by the Nagasaki Agricultural Experiment Station for trial. For comparison, another plant representing a typical Owari tree was chosen from a near-by orchard, which will be presented afterwards. The description of the former plant is given below :

Lot No. 18 of 1919. Ikiriki Satsuma in the orchard of Toranoshin SHIGENOBU (Kôkwaen orchard), at Yoshino-mura, Kagoshima-gun, Kagoshima-ken. Moderately large-sized tree on a plateau, just below a small hill, located at the turn of the main road leading from the residence to a stable-manure yard, north-west corner, planted 2.6 m. away from adjacent trees, having an E-W spread of 2.9 m., N-S spread of 2.6 m., and height of 2.3 m. Branches moderately spreading, not drooping, shoots not crowded, forming round head, unpruned. Leaves medium-sized, with broad base, considerably light-colored and acutely pointed apex showing effect of malnutrition. It is said that no fertilizer has been applied during the past four or five years. Soil rather rich, of medium grade. The fruit on the tree looked flat and bright-colored. The measurements of the fruits are given in Table 25.\*

\* PL. III, Fig. 1.

TABLE 25.

MEASUREMENT OF SATSUMA FRUITS RECEIVED AS IKIRIKI FROM KÔKWAEN ORCHARD IN KAGOSHIMA. LOT NO. 18 OF 1919. TOTAL NUMBER OF FRUITS, 108

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.72 cm.	4.09 cm.	1.38	71.67 gm.	—	10.86	2.63 mm.	12.38 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	108	—	—	—	—	—	65	% 60.19
Sinuate based fruits	108	—	—	—	—	—	12	11.11
Semi-sinuate based fruits		(not observed)						
Areolated fruits	108	—	—	—	—	—	17	15.74
Frs. with undeveloped calyx lobes	26	—	—	—	—	—	1	3.85
Frs. with long narrow calyx lobes	26	—	—	—	—	—	1	3.85
Fruits containing seeds	108	—	—	—	—	—	78	72.22
Apical depression	107	1 0.93	16 19.95	63 58.88	27 24.23%	—	—	—
Apical dots	107	0 0	11 10.25	96 89.72%	—	—	—	—
Flatness of fruit	108	17 15.74	79 73.15	11 10.19	1 0.93	0 0%	—	—
Smoothness of fruit	107	18 16.82	67 62.62	20 18.69	0 0	2 1.87%	—	—
Thinness of rind	108	101 93.52	7 6.45	0 0	0 0	0 0%	—	—
Thinness of segment wall	107	80 74.77	23 21.50	3 2.80	1 0.93	0 0%	—	—
Color of pulp	107	70 65.42	34 31.78	3 2.80	0 0	0 0%	—	—
Size of central column	107	2 1.87	12 11.21	85 79.44	8 7.48	0 0%	—	—
Quantity of pith	107	8 7.48	39 36.45	58 54.21	2 1.87	0 0%	—	—
Quality of pulp	107	42 39.25	40 37.38	19 17.76	6 5.61	0 0%	—	—

The figure in the table shows that this is more flat and smoother than the Ikiriki fruits at Nagasaki Station. The rind is also thinner and the central column is slightly smaller. Although the color of the pulp is lighter, due to the lack of fertilization, the range of the quality of pulp is very similar. The navel is very well developed, and seeds are abundant, due to mixed planting.

The Owari tree used for comparison in the same locality is described as follows:

Lot No. 21 of 1919. Well bearing Owari tree in the orchard of Yashirō SETOGUCHI (Hōkwaen orchard), in Yoshino-mura, near Kagoshima City, located on a sandy soil of volcanic origin with coarse pebbles 58 cm. deep, rather fertile in nature. Situated in a middle plot on nearly flat land, middle passage No. 4, just opposite and below a Kaki Persimmon tree on the embankment, 2nd tree from west along the passage. The tree was bought from Inosuke SHIRAKUSA of Idzumi Province in Ōsaka Prefecture, under the name "Kairyō Unshū" (Improved Satsuma). Tree distance 2.6 m., moderately large, unpruned tree planted 16 years ago, E-W spread 2.9 m., N-S spread 2.3 m., height 2 m., shoots of upright habit with a few elongated drooping branches. Leaves all large, undulate, both ends broad, rounded at the apex, deep-colored. The tree is fertilized with 3 shō (5.5 litres) of chicken manure and the same amount of a mixture of rape seed cake and bone dust. There are about 1000 trees of the same origin, yielding good crops each year, which sell at 3.40–3.80 yen per 40 kin (14.16–15.83 yen per 100 kg.), mostly being shipped to Luchu. Picking season from the beginning of November to 20th of December. It is noticed that thorns are frequently found on autumn shoots. The entire crop of the representative plant mentioned here was picked for study. The measurement data is given in Table 26.\*

Although this was a very large lot including many culls, the flatness is more pronounced than in the preceding. The apical area without oil cell dots and areola marking is more conspicuous, and the surface is more rough, and is associated with a thicker rind. These characters are

\* PL. III, Fig. 2.

TABLE 26.

MEASUREMENT OF OWARI FRUITS GROWN AT HÔKWAEN ORCHARD NEAR KAGOSHIMA CITY. LOT NO. 21 OF 1919. TOTAL NUMBER OF FRUITS, 614

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.17 cm.	4.07 cm.	1.42	67.05 gm.	—	10.76	2.47 mm.	12.46 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	614	—	—	—	—	—	69	% 11 24
Sinuate based fruits	614	—	—	—	—	—	3	0.49
Semi-sinuate based fruits		(not observed)						
Areolated fruits	614	—	—	—	—	—	305	49.67
Frs. with undeveloped calyx lobes	486	—	—	—	—	—	82	16.87
Frs. with long narrow calyx lobes	486	—	—	—	—	—	32	6.58
Fruits containing seeds	614	—	—	—	—	—	107	17.43
Apical depression	608	91 14.97	222 36.51	270 44.41	25 4.11%	—	—	—
Apical dots	608	177 29.11	276 45.39	155 25.49%	—	—	—	—
Flatness of fruit	595	240 40.34	317 53.28	37 6.22	1 0.17	0 0%	—	—
Smoothness of fruit	514	15 2.92	433 84.24	51 9.92	6 1.17	9 1.75%	—	—
Thinness of rind	614	443 72.15	133 21.66	33 5.39	4 0.65	1 0.16%	—	—
Thinness of segment wall	613	557 90.86	52 8.48	1 0.16	3 0.49	0 0%	—	—
Color of pulp	611	246 40.26	325 53.19	40 6.55	0 0	0 0%	—	—
Size of central column	611	7 1.15	111 18.17	481 78.72	9 1.47	3 0.49%	—	—
Quantity of pith	609	0 0	31 5.09	512 84.07	63 10.34	3 0.49%	—	—
Quality of pulp	606	151 24.92	289 47.69	158 26.07	7 1.16	1 0.17%	—	—

unquestionably associated with the condition of over fertilization, and is quite frequent in Owari Satsuma grown in other places. The thinner segment wall and little amount of pith at the central column are also commonly associated characters as will be seen in numerous material shown later on. Since the picking of fruits was considerably late and they were studied after a long period of storage, the color of the pulp was found much faded, and the taste was insipid. The above given data presents somewhat different results, due to a great diversity of fertilization, but still it is easy to conclude that both belong to the same variety from the general characters of the fruit and the vegetative organs.

### FURTHER STUDIES IN THE KOGAKEI SATSUMA

Since the previous investigation on the Kogakei Satsuma was thought insufficient, and the character of the Kogakei was not very clear to the writer, another plant of the Kogakei Satsuma was chosen for study, besides the individual, mentioned before, from Nakagawa Station. This representative plant was selected from the trees of Mr. BUTÔ's orchard in Ikiriki village. Mr. Shikatarô BUTÔ was the executive officer of the village, and his statement of the definite Koga origin of the selected plant was reliable. The tree is said to have been planted and cared by his father Takejirô BUTÔ, who introduced the plant about 50 years ago. It came from Koga village, locally called "KOGANAE", and he says that same variety represents about one-tenth of the total planting in Ikiriki. The description of the chosen plant is as follows:

Lot No. 23 of 1919. Kogakei Satsuma from BUTÔ's orchard in Ikiriki. Large-sized tree in the plot above the house, on the second row from below, nearest the road. (South of the Natsudaidai plot). Planted at a distance of 3.5 m., having an E-W spread of 3.5 m., a N-S spread of 4.4 m., a height of 3.8 m. Branches many, divergent without order but not drooping; leaves large, hanging, deep-colored, undulate but thin; fruits on tree scabby and sooty due to neglect of the tree. The entire crop of a single branch was used for taking measurements. Fruits are generally picked at the beginning of December and sold at 7 yen per 100 kin

(11.67 yen per 100 kg.) The soil is rich in organic matter without containing pebbles; is not mulched but vegetables are raised under the tree. The measurements of fruits are given in Table 27.\*

The figure in the table shows that the flatness range is almost similar to that of the Kogakei fruits from Nakagawa Station, though the absolute figure shows a much more flat shape in this lot. It is remarkable that fruit with a sinuate base is abundant, and it is still more round at the apex, with more dots around the styler point. The surface is more roughened, probably due to an infection of sour scab, but other characters are very similar to the plant of the Nakagawa Station, the quality of fruit being slightly better, though not excellent.

In order to obtain a confirmation of the data of Mr. BUTÔ's Kogakei Satsuma, all the fruits from two limbs of a neighbouring tree (the middle tree of the southernmost row, facing the south) were picked and studied in the next year. The fruits were medium-sized, with an appearance of medium or medium-high shape and somewhat conical, but were not fluted at all. The texture of the rind was hard and stiff, and it was regularly pitted. The stem end was sinuate, less grooved and the calyx was rather small with many fruits having undeveloped lobes. Navel mark and areola was not prominent. Very tight-skinned. The measurements of the fruits are given in Table 28.\*\*

As the figure shows, this lot has a very regular outline, a gradually narrowed, and practically all sinuate base. The apical depression is not strong, it is naveled to a certain extent, and oil cell dots are more or less lacking at the styler end. In the cross-section, it is noticed that this has a regularly thick rind, uniformly thin wall, regular and rather small central column, little amount of pith, and an uniformly intense but acidulous pulp.

This lot has a rounder outline than the lot studied in the previous year. The indication of the flatness of fruit by the diameter-height index often does not agree with the impression obtained by the eye. This is possibly due to the difference in the shape of the shoulder and the extent

\* PL. III, Fig. 3.

\*\* PL. III, Fig. 4.

TABLE 27.

MEASUREMENT OF SATSUMA FRUITS OF KOGAKEI TREE IN BUTO'S ORCHARD  
IN IKIRIKI. LOT NO. 23 OF 1919. TOTAL NUMBER OF FRUITS, 101

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.26 cm.	4.30 cm.	1.44	77.62 gm.	—	11.36	2.69 mm.	16.85 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	101	—	—	—	—	—	67	% 66.33
Sinuate based fruits	101	—	—	—	—	—	57	56.34
Semi-sinuate based fruits		(not observed)						
Areolated fruits	101	—	—	—	—	—	1	0.99
Frs. with undeveloped calyx lobes	57	—	—	—	—	—	26	45.61
Frs. with long narrow calyx lobes	57	—	—	—	—	—	0	0
Fruits containing seeds	101	—	—	—	—	—	31	30.69
Apical depression	100	2 2.00	4 4.00	54 54.00	40 40.00%	—	—	—
Apical dots	100	5 5.00	8 8.00	87 87.00%	—	—	—	—
Flatness of fruit	101	5 4.95	36 35.64	59 58.42	1 0.99	0 0%	—	—
Smoothness of fruit	101	0 0	0 0	75 74.26	26 25.74	0 0%	—	—
Thinness of rind	101	25 24.75	40 39.60	26 25.74	7 6.93	3 2.97%	—	—
Thinness of segment wall	101	51 50.50	34 33.66	14 13.86	1 0.99	1 0.99%	—	—
Color of pulp	100	83 83.00	15 15.00	1 1.00	0 0	1 1.00%	—	—
Size of central column	101	1 0.99	9 8.91	72 71.29	11 10.89	8 7.92%	—	—
Quantity of pith	101	3 2.97	45 44.55	49 48.51	4 3.96	0 0%	—	—
Quality of pulp	94	12 12.77	39 41.49	33 35.11	9 9.57	1 1.06%	—	—

TABLE 28.

MEASUREMENT OF KOGAKEI SATSUMA FRUITS OF BUTÔ NO. 23 (1919) TREE IN IKIRIKI. NEW LOT NO. 62 OF 1920. TOTAL NO. OF FRUITS, 45 (NOS. 1018-1062)

Av. Girth	Av. Height	D/E Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.56 cm.	4.66 cm.	1.34	91.66 gm.	10.09 mm.	11.03	3.22 mm.	12.32 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	45	—	—	—	—	—	11	% 26.67
Sinuate based fruits	45	—	—	—	—	—	43	95.56
Semi-sinuate based fruits	45	—	—	—	—	—	2	4.44
Areolated fruits	45	—	—	—	—	—	13	28.89
Frs. with undeveloped calyx lobes	44	—	—	—	—	—	23	63.63
Frs. with long narrow calyx lobes	44	—	—	—	—	—	0	0
Fruits containing seeds	45	—	—	—	—	—	5	11.11
Apical depression	45	4 8.89	14 31.11	22 48.89	5 11.11%	—	—	—
Apical dots	45	7 15.56	31 68.88	7 15.56%	—	—	—	—
Flatness of fruit	45	1 2.22	10 22.22	22 48.89	11 24.44	1 2.22%	—	—
Smoothness of fruit	45	0 0	10 22.22	34 75.56	1 2.22	0 0%	—	—
Thinness of rind	45	1 2.22	15 33.33	27 60.00	2 4.44	0 0%	—	—
Thinness of segment wall	45	33 84.45	6 13.33	1 2.22	0 0	0 0%	—	—
Color of pulp	45	1 2.22	14 31.11	30 66.67	0 0	0 0%	—	—
Size of central column	45	0 0	1 2.22	24 53.33	16 35.56	4 8.89%	—	—
Quantity of pith	45	0 0	1 2.22	33 73.33	10 22.22	1 2.22%	—	—
Quality of pulp	45	2 4.44	7 15.56	27 60.00	9 19.99	0 0%	—	—



of the depression of the end. The high shouldered, less depressed fruits of the Kogakei appear more round to the sight than the actual D/H index shows. On the other hand, fruits of the Owari variety generally have a low shoulder and deeper depression at the ends, unless the condition does not permit full expansion, so that these two types of fruits are very different to the eye although the D/H index approaches fairly closely at times. In this respect, fruits of the Kogakei and the Ikeda belong to the same class, and the former probably gave rise to the latter during the course of multiplication and the change of local conditions.

*Comparison of the Kogakei Satsuma and the Ikeda*

A search was made in Nagasaki to locate Zairai trees having a definite history showing their introduction from Tanushimaru, where this variety is grown extensively. No such trees were found in the village of Ikiriki. It was learned, however, that Mr. Kenzaburō OGATA, the village mayor, had distributed Ikeda trees many years ago, so that it was found possible to compare the Kogakei with the Ikeda. A small planting of Ikeda Satsuma in the orchard of Seisaku MORIGUCHI, at Ōkubo, Funatsu-gō, Ikiriki village, was brought to the author's attention. There four trees were found bearing a normal crop and they appeared true to type. One of these trees was chosen as the representative individual and the study of the fruit was made. The description of the tree is as follows:

Lot. No. 10 of 1919. Ikeda tree, 26 years after planting, in MORIGUCHI's orchard. Trees planted at a distance of 2.6 m. apart, the 4th tree on the slope, having E-W spread 2.2 m., N-S spread 2.6 m., height 2.3 m. Unpruned, moderately open tree with many small, thin, weak looking twigs; leaves normal, dispersed, small but hanging. Fruits were abundant on tree, normal, light-colored. Fertility of the soil of the orchard medium, being clayey loam with pebbles, well drained by an under-ground stony bed. Only night soil is applied for fertilizer. The fruit is sold much cheaper than that of Ikiriki and Kogakei, i. e., 5 yen per 100 kin (8.33 yen per 100 kg.) The measurements of the fruits are given in Table 29.\*

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\* PL. IV, Fig. 2.

TABLE 29.

MEASUREMENT OF SATSUMA FRUITS OF IKEDA VARIETY FROM MORIGUCHI'S ORCHARD IN IKIRIKI. LOT NO. 10 OF 1919. TOTAL NUMBER OF FRUITS, 439

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
15.26 cm.	4.72 cm.	1.02	80.85 gm.	—	10.82	2.39 mm.	9.97 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	439	—	—	—	—	—	50	% 11.39
Sinuate based fruits	439	—	—	—	—	—	132	30.07
Semi-sinuate based fruits		(not observed)						
Areolated fruits	439	—	—	—	—	—	230	52.39
Frs. with undeveloped calyx lobes	83	—	—	—	—	—	47	56.62
Frs. with long narrow calyx lobes	83	—	—	—	—	—	6	7.23
Fruits containing seeds	439	—	—	—	—	—	84	19.13
Apical depression	434	12 2.76	63 14.52	137 31.57	222 51.15%	—	—	—
Apical dots	433	5 1.15	77 17.78	351 81.06%	—	—	—	—
Flatness of fruit	431	1 0.23	198 45.94	222 51.51	0 0	0 0%	—	—
Smoothness of fruit	439	7 1.59	83 18.91	229 52.16	120 45.34%		—	—
Thinness of rind	439	46 10.48	123 28.02	166 39.81	69 15.72	35 7.97%	—	—
Thinness of segment wall	439	302 68.79	105 23.92	16 3.64	12 2.73	4 0.91%	—	—
Color of pulp	439	115 26.20	219 49.89	94 21.41	0 0	39 2.51%	—	—
Size of central column	439	5 1.14	50 11.39	301 68.56	63 14.35	20 4.56%	—	—
Quantity of pith	434	3 0.69	22 5.07	219 50.46	163 37.56	27 6.22%	—	—
Quality of pulp	426	42 9.86	125 29.34	176 41.31	58 13.62	25 5.87%	—	—

This figure clearly shows that the fruits are small and extremely round, many with undeveloped calyx lobes, while the body of the calyx is much elevated, almost continuous to the stem. The apex is very much rounded, with a fairly well developed areola, which is somewhat different in extent from that of the Kogakei fruit. Apical dots are well developed, as in most of the Kogakei fruits, but the roughness of the surface is pronounced and the color of fruit is considerably lighter. The thinness of rind and segment wall, size of central column, and the amount of pith, as well as the quality of fruit, are fairly similar, but the peculiarly flattened and not sinuate stem-end is very different. From the above comparison, the difference between Kogakei and Ikeda is very clear in trees under a similar condition. It was learned later that individual difference of the D/H index of Ikeda fruits is fairly great, and that the figure for this individual is rather too extreme, and possibly does not represent the varietal character properly. The Ikeda plant is very productive, yielding a larger amount of fruit than the Kogakei, though the relative size is much smaller.

It was thought very desirable to investigate the crop of the same tree in another year, but unfortunately the tree had been cut down for the purpose of thinning the orchard. A substitute tree was therefore picked from the same orchard in the succeeding year, the description of which is as follows:

Lot No. 55 and 56 of 1920. MORIGUCHI's Ikeda tree, 29 years old, E-W spread 4.6 m., N-S spread 4.75 m., height 3.33 m. An upright grower having thin branches, new shoots often drooping, foliage rather loose. Leaves small, narrow, typically very slender, tapering at both ends, acute angled to petiole. Abnormal leaves are very short, rhombic, with narrowed base. The measurements of the fruits are given in Table 30.\*

These figures are rather different from those of last year's tree, and apparently show the another extreme of the variety. The fruit is rough skinned, deeply grooved, strongly areolated, rather prominently naveled,

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\* PL. IV, Fig. 3

TABLE 30.

MEASUREMENT OF MORIGUCHI'S IKEDA FRUITS IN THE SECOND YEAR (LOT NO. 55 & 56), FROM A TREE ADJACENT TO LOT 10 OF 1919.  
FRUIT NOS. 1014-1015, 4860-5110, TOTALING 253.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.77 cm.	4.50 cm.	1.40	90.57 gm.	9.89 mm.	10.52	2.88 mm.	15.37 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	250	—	—	—	—	—	125	50.00%
Sinuate based fruits	250	—	—	—	—	—	128	51.30
Semi-sinuate based fruits	250	—	—	—	—	—	29	11.60
Areolated fruits	250	—	—	—	—	—	223	89.20
Frs. with undeveloped calyx lobes	249	—	—	—	—	—	56	22.49
Frs. with long narrow calyx lobes	249	—	—	—	—	—	14	5.62
Fruits containing seeds	253	—	—	—	—	—	101	39.92
Apical depression	250	13 5.20	69 27.60	138 55.20	30 12.00%	—	—	—
Apical dots	250	3 1.20	72 28.80	175 70.00%	—	—	—	—
Flatness of fruit	250	23 9.20	111 44.40	105 42.00	11 4.40	0 0%	—	—
Smoothness of fruit	250	2 0.80	16 6.40	151 60.40	31 12.40	50 20.00%	—	—
Thinness of rind	253	103 40.71	105 41.50	44 17.39	1 0.40	0 0%	—	—
Thinness of segment wall	253	70 27.67	120 47.43	57 22.53	6 2.37	0 0%	—	—
Color of pulp	253	202 79.84	45 17.79	5 1.98	1 0.40	0 0%	—	—
Size of central column	253	3 1.19	50 19.76	174 68.78	25 9.88	1 0.40%	—	—
Quantity of pith	252	0 0	27 10.71	215 85.32	10 3.97	0 0%	—	—
Quality of pulp	250	68 27.20	82 32.80	79 31.60	20 8.00	1 0.40%	—	—

with moderately depressed outline. Calyx is small, more or less deeply sinuate at the stem-end, without any sign or crater-like depression around. Section of fruit shows irregular outline, due to fluted surface. Rind is rather thin, segment wall rather thick, central column medium-sized, containing medium amount of pith, pulp deep-colored and rather intense in flavor, though acidulous. The occurrence of fluted fruit within the variety Ikeda is here met for the first time, but this variation is frequent in the Kogakei Satsuma, as is described in the next chapter. It is quite possible that the round-fruited varieties like Ikeda and Zairai present fluted fruits when an abrupt expansion takes place, due to unusual conditions of the tree. This seldom occurs in the Owari variety. When conditions favor such expansion in the Owari fruit they will cause rough-skinned conical fruit with a distinct crater-like stem-end and very deeply concave apex. These characteristic behaviors of both groups of varieties are rather remarkable, throwing a line of demarcation between them.

From the observations made in the succeeding years, a tentative description of the Ikeda variety is given as follows :

"A small round deep-colored Satsuma with deeply pitted or harshed surface. Texture of rind is obviously coarse, oil cells small and many, having same color with, or deeper colored than, the matrix. Roughness of skin is often very much pronounced in spite of the small size of fruit. Calyx comparatively small, lobes more or less swollen (tall), lobes irregular, acutely triangular, not broad-acuminate, disk small and not spreading outward. Apex is often very strongly areola-marked, flat or less depressed, navel existing or lacking. The shape of fruit is round when seen *en masse*. Single fruit may become distinctly flat, but in this case the outline becomes very irregular (fluted). Basal groove rarely prominent but occasionally is absolutely lacking. The grooved area, when existing, never becomes crater-like, but the stem-end is generally shallowly pressed in, or sinuate, but not usually very sharply sinuous all through. Calyx is distinctly small-sized."

Further studies in the Ikeda variety are given in other places.

*The Zairai variety in the Tanushimaru region*

In order to understand the standard form of the Zairai variety, a search was made in the Tanushimaru region to locate plants as old as possible, which have a long record of supplying budsticks to local nurseries. An old orchard was found in the grounds of the Anchôji temple in Moribe, Minô-mura, Ukiha-gun, not far from Tanushimaru. The trees were about 90 years old, having been planted by Keigaku GYÔTOKU, grandfather of the present owner, Getto GYÔTOKU. All of them were on trifoliate roots, and appeared very upright, due to close planting. The soil looked fairly good, blackish, fertile, without pebbles. Fertilizers used are almost confined to fish cake and wood ash in addition to night soil. It is said that the fruits are stored until February, after being picked from the beginning of November to the middle of December. They are mainly sold in Kurume City and Tanushimaru, at 5.00–6.00 yen per 100 kin (8.33–10.00 yen per 100 kg.) during the season, but the price rises up to 10.00 yen per 100 kin (16.67 yen per 100 kg.) in February. Further description of the tree used for the measurement of the fruit is given below :

Lot No. 22 of 1919. Zairai tree about 90 years old, planted in the ground back of Anchôji temple, located at the foot of a mountain. The tree is at the north of a house, 2nd row from east, the north neighbour of the tree with a forked trunk, being planted 1.75 m. away from the others and looking very much crowded. E-W spread of the tree 5.2 m., N-S spread 2.6 m., height 4.35 m., girth of trunk 55 cm. at a point 30 cm. from the ground. Branches not many, drooping, upright; leaves more or less hanging, broad, but not very large in size and more or less undulate, apex not pointed sharply and the base rather broad. The measurements of the fruits are given in Table 31.\*

Although this lot contained a large quantity of culls, moderately tall fruit, very abundant sinuate-based fruit, and a fairly large number of calyces with not well developed lobes were characteristic. The range of grades in the rind, segment wall, color of pulp and other

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\* PL. V, Fig. 1.

TABLE 31.

MEASUREMENT OF SATSUMA FRUITS OF ZAIRAI VARIETY FROM ANCHÔJI  
GROUND NEAR TANUSHIMARU IN FUKUOKA PREFECTURE.  
LOT NO. 22 OF 1919. TOTAL NUMBER OF FRUITS, 547.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.27 cm.	4.68 cm.	1.24	80.51 gm.	—	10.12	2.97 mm.	10.59 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	547	—	—	—	—	—	18	% 3.29
Sinuate based fruits	545	—	—	—	—	—	522	95.82
Semi-sinuate based fruits		(not observed)						
Areolated fruits	547	—	—	—	—	—	13	2.38
Frs. with undeveloped calyx lobes	286	—	—	—	—	—	150	52.45
Frs. with long narrow calyx lobes	286	—	—	—	—	—	2	0.70
Fruits containing seeds	547	—	—	—	—	—	183	33.46
Apical depression	544	6 1.10	45 8.27	286 52.57	207 38.05%	—	—	—
Apical dots	544	14 2.57	143 26.29	387 71.14%	—	—	—	—
Flatness of fruit	546	0 0	78 14.29	330 60.44	115 21.06	23 4.21%	—	—
Smoothness of fruit	547	0 0	24 4.38	269 49.18	244 44.61	10 1.83%	—	—
Thinness of rind	545	98 17.98	182 33.39	141 25.87	56 10.28	68 12.48%	—	—
Thinness of segment wall	545	161 29.54	194 35.60	114 20.92	42 7.71	34 6.24%	—	—
Color of pulp	545	414 75.96	113 20.73	14 2.57	0 0	0 0%	—	—
Size of central column	545	1 0.18	3 0.55	360 66.06	119 21.83	62 11.38%	—	—
Quantity of pith	545	77 14.13	220 40.37	237 43.49	11 2.02	0 0%	—	—
Quality of pulp	525	30 5.71	162 31.46	247 47.05	67 12.76	19 3.62%	—	—

interior characters are quite similar to the Kogakei fruit of Lot No. 23, and the fruit was not so small as the Ikeda, not so extremely tall, nor tree so productive. Tree and leaf characters are nearer to the Owari or the Ikiriki than the Ikeda, having large leaves not conspicuously pointed at the ends. As far as the comparison of materials used for study indicates, the Zairai variety is unquestionably identical with the Kogakei. This conclusion agrees with the result obtained in the previous years as stated before.

### VARIATION IN THE KOGAKEI-ZAIRAI

During the period when the field work was under way, the writer found an individual in the Nagasaki Agricultural Experiment Station recorded as Ikiriki but appearing like Kogakei. The parentage and the history of this plant was unknown, and the tree was not in the regular Ikiriki plot. No sufficient explanation was given by the staff of the Station as to why this was called "Ikiriki". It perhaps means that the plant came from the village of Ikiriki, but does not definitely mean the name of the variety. The study of the tree was made by the usual individuality method. The description of the tree is given below :

Lot No. 3 of 1919. So-called Ikiriki tree at Nakagawa Station, Nagasaki, 14 years old in plot No. 5, planted at the distance of 2.6 m. on a slope, being the 3rd tree in the lowermost row. Medium-sized tree, E-W spread 2.6 m., N-S spread 2.9 m., height 2 m., conical shaped, branches large, branchlets not drooping decidedly and foliage dense. Leaves smaller and not hanging, distinctly more boat-shaped than Owari, shape more or less oblanceolate, with acute pointed apex. Fruits appeared roundish, fluted, not smoothly rounded. No difference in the time of maturity of fruit is noticed compared with other individuals of the Station. The measurements of the fruits are given in Table 32.\*

In comparing these figures with those of Lots No. 1 and No. 2 (Tables 21 and 22), it will soon be noticed that this is somewhat in-

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\* PL. V, Fig. 2.



TABLE 32.

MEASUREMENT OF SATSUMA FRUITS FROM TREE SAID TO BE IKIRIKI, AT  
NAGASAKI AGR. EXP. STAT. LOT. NO. 3 OF 1919. TOTAL  
NUMBER OF FRUITS, 467

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.17 cm.	4.52 cm.	1.28	77.61 gm.	—	10.77	2.43 mm.	12.14 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	467	—	—	—	—	—	80	17.13%
Sinuate based fruits	465	—	—	—	—	—	56	12.04
Semi-sinuate based fruits		(not observed)						
Areolated fruits	466	—	—	—	—	—	80	17.17
Frs. with undeveloped calyx lobes	28	—	—	—	—	—	13	46.43
Frs. with long narrow calyx lobes	28	—	—	—	—	—	0	0
Fruits containing seeds	467	—	—	—	—	—	359	76.87
Apical depression	464	58 12.50	210 45.26	196 42.24%	—	—	—	—
Apical dots	465	65 13.98	238 47.34	252 38.28%	—	—	—	—
Flatness of fruit	464	21 4.53	151 32.54	259 55.82	33 7.12	0 0%	—	—
Smoothness of fruit	464	27 5.82	109 23.49	232 50.00	84 18.10	12 2.59%	—	—
Thinness of rind	459	263 57.30	158 14.92	30 2.23	2 0.42	6 1.31%	—	—
Thinness of segment wall	466	229 49.14	177 37.98	41 8.80	17 3.85	2 0.43%	—	—
Color of pulp	466	399 85.62	50 10.73	5 1.07	0 0	12 2.58%	—	—
Size of central column	466	1 0.21	12 2.58	324 69.53	95 20.39	34 7.30%	—	—
Quantity of pith	466	32 6.87	194 41.63	193 41.42	41 8.80	6 1.29%	—	—
Quality of pulp	458	113 24.67	202 44.10	111 24.24	22 4.80	10 2.18%	—	—

intermediate between them, but nearer to Kogakei (No. 1). This has thicker rind, thicker segment wall, larger amount of pith, and very much larger central column, and the skin is more rough, pulp deeper colored and there are a fewer number of sinuate based fruits. From this data, it is hard to tell to what variety it belongs, but judging from the character of the tree, this was concluded to be an off-type of Kogakei-Zairai, having a tendency to bear flat fruit. This has a conspicuously fluted surface, and, as is stated before, there is a general tendency for a round-fruited variety to become fluted when an abrupt expansion takes place or when such is the habit of the individual.

To verify this view, another fluted Kogakei individual was brought into the investigation. This plant was in the orchard of Kinzô Mizomoto, located on the plateau of Tagashira in Funatsu-gô, Ikiriki village. There were a number of round-fruited Kogakei trees in the same orchard, but occasional flat-fruited individuals were seen among them. One of these trees was used for the study. This is described below :

Lot No. 8 of 1919. Kogakei (Zairai) tree in Mizomoto's orchard, about 25 years old. Original budwood was taken from an old tree growing in Koga-mura, the place from which the Kogakei plants were distributed, propagated by the owner of the tree. Second tree from south and east, being a well-pruned individual, planted at the distance 3.5 m. from the west, 2.9 m. from the south, having an E-W spread of 3.5 m., a N-S spread of 3.5 m., and a height of 2.6 m. An upright grower, with many upright and divergent branches, branchlets thick, not short, erect, dense, not dispersed. Leaves well developed, dense, internode short, erect, boat-shaped, very broad, not hanging, obtuse at both ends, blunt tipped. Soil where the plant is grown is pebbled loam, being fairly fertile. Fertilizer applied : 2.5 shô (4.5 litres) of bean cake. The Kogakei Zairai is not abundant in the village, and is only planted in a small quantity in Nakadôri-gô. The picking season is the early part of December, the fruit is sold at Nagasaki and Saseho, at 7.00 yen per 100 kin (11.67 yen per 100 kg.) The measurements of fruits are given in Table 33.\*

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\* PL. VI, Fig. 1.

TABLE 33.

MEASUREMENT OF SATSUMA FRUITS OF KOGAKEI FROM MIZOMOTO'S  
ORCHARD IN IKIRIKI. LOT NO. 8 OF 1919. TOTAL NUMBER  
OF FRUITS, 550

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.73 cm.	4.27 cm.	1.47	68.21 gm.	—	10.62	2.56 mm.	11.07 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	550	—	—	—	—	—	308	56.00
Sinuate based fruits	548	—	—	—	—	—	178	32.48
Semi-sinuate based fruits	548	—	—	—	—	—	36	6.57
Areolated fruits	550	—	—	—	—	—	111	20.18
Frs. with undeveloped calyx lobes	260	—	—	—	—	—	78	30.00
Frs. with long narrow calyx lobes	260	—	—	—	—	—	10	3.85
Fruits containing seeds	550	—	—	—	—	—	50	9.09
Apical depression	542	66 12.18	161 29.70	183 33.76	132 24.35%	—	—	—
Apical dots	544	45 8.27	243 44.67	256 47.06%	—	—	—	—
Flatness of fruit	546	7 1.23	229 41.94	250 45.79	51 9.34	9 1.65%	—	—
Smoothness of fruit	547	2 0.37	101 18.46	208 38.03	180 32.91	56 10.24%	—	—
Thinness of rind	550	246 44.73	187 34.00	84 15.27	17 3.09	16 2.91%	—	—
Thinness of segment wall	548	490 89.42	50 9.12	4 0.73	4 0.73	0 0%	—	—
Color of pulp	541	460 85.03	73 13.49	7 1.29	0 0	1 0.18%	—	—
Size of central column	549	7 1.28	53 9.65	304 55.37	100 18.21	85 15.48%	—	—
Quantity of pith	546	8 1.47	35 6.41	332 60.81	142 26.01	29 5.31%	—	—
Quality of pulp	526	223 42.40	189 35.55	91 17.30	24 4.56	1 0.19%	—	—

The characteristics of the fruit are the fluted surface and the truncate base, which are caused by unusual expansion. Basal grooves are also developed, although sinuate based fruits are fairly abundant. The figures show that the flatness is fairly pronounced, and it is now clear that flatness is sometimes a feature of the Zairai fruit. All other points are very similar to the individual of the Nakagawa Station.

*Further study of fluted Kogakei-Zairai*

There arose a question if such fluted flat-fruited character is merely a temporary character, forming an annual variation, or a definite individuality. To make this point clear, the crop of the same tree was studied again in the next year (1920). The measurements of these 1920 fruits are given in Table 34.\* The field observation is also recorded below :

The appearance of the fruits is exactly similar to those of the preceding year, i. e., fluted, not so even as those of BUTÔ's Kogakei (Lot No. 23, Table 27). The texture of the rind is stiff and brittle, the apical depression strong and some have abrupt depressions inside the areola.

The general observation of the cross-section of the fruit is as follows :

The rind of each fruit is irregular in thickness, segment wall is mostly thick, central column large, possibly by abrupt expansion, segments mostly rounded at both ends, pulp acidulous, not attaining to full maturity, juicy but not melting, of inferior quality, although the tree is well cared and properly pruned.

The fruit of this lot is not very flat, as the D/H index indicates, but when the fruit is observed on the table, it looks still less flat, because the shoulder is high and ends are depressed, and are more or less cylindrical in nature. It is most likely that the increased flatness of last year's fruit was caused by the puffing of the rind, which was not the

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\* PL. VI, Fig. 2.

TABLE 34.

MEASUREMENT OF KOGAKEI SATSUMA FRUITS FROM MIZOMOTO'S ORCHARD  
IN IKIRIKI, SAME TREE GIVEN IN TABLE 33. LOT NO. 36 OF 1920.  
TOTAL NUMBER OF FRUITS, 90 (NO. 875-964).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.80 cm.	4.49 cm.	1.33	82.86 gm.	9.56 mm.	10.38	2.97 mm.	13.10 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	90	—	—	—	—	—	35	% 38.89
Sinuate based fruits	90	—	—	—	—	—	39	43.33
Semi-sinuate based fruits		(not observed)						
Areolated fruits	90	—	—	—	—	—	56	62.22
Frs. with undeveloped calyx lobes	86	—	—	—	—	—	36	41.86
Frs. with long narrow calyx lobes	86	—	—	—	—	—	2	2.33
Fruits containing seeds	90	—	—	—	—	—	6	6.67
Apical depression	88	16 18.18	30 34.09	40 45.45	2 2.27%	—	—	—
Apical dots	90	5 5.56	30 33.33	55 61.11%	—	—	—	—
Flatness of fruit	90	0 0	14 15.56	54 60.00	20 22.22	2 2.22%	—	—
Smoothness of fruit	90	2 2.22	29 32.22	42 46.67	17 18.89	0 0%	—	—
Thinness of rind	90	22 24.44	29 32.22	33 36.67	6 6.67	0 0%	—	—
Thinness of segment wall	90	29 32.22	24 26.67	24 26.67	13 14.44	0 0%	—	—
Color of pulp	90	11 12.22	21 23.33	37 41.44	16 17.78	5 5.56%	—	—
Size of central column	90	1 1.11	17 18.89	59 65.56	12 13.33	1 1.11%	—	—
Quantity of pith	90	11 12.22	35 27.78	50 55.56	2 2.22	2 2.22%	—	—
Quality of pulp	90	0 0	19 21.11	50 55.56	17 18.89	4 4.44%	—	—

case this year. Since the fruit was not fully mature, the color and quality of the pulp is low in comparison with the figures of last year, but the fully expanded central column, apical depression, apical dots, etc. are all alike. The rind is a little thicker, the segment wall very much thicker, and these characters seem to have a greater annual variation than the others.

Two other fluted, flat-fruited individuals of the same orchard of MORIGUCHI were used for comparison in 1920. Details of these trees are given below, and the measurements of fruits are tabulated in Table 35 and Table 36.

Lot No. 37 of 1920. Tree east of individual No. 8 of 1919 and 36 of 1920. E-W spread of the tree 2.9 m., N-S spread 3.2 m., height 2.6 m. Branches dense, a few upright shoots standing at the top, foliage dense. Leaves rather broad, fruit looked round on tree. Measurements in Table 35.\*

General appearance of the fruit of Table 35 is as the preceding (Lot No. 36, Table 34). Size of fruit is a little larger, calyx rather large, fruit surface similarly more or less fluted, depressed at the base and more or less grooved. In cross-section, rind is thin, central column rather small and regular, all other points same as the preceding. A few fruits have a large core, are irregular in shape, just as those encountered in the preceding lot. Number of segments variable in both lots, ranging from 8 to 12. In rare cases, the segment wall is hardened and adherent to the pulp, which is a deteriorating character.

Lot No. 34 of 1920. Tree north-east of individual No. 8 of 1919 and 36 of 1920. Head of the tree round, without upright branches, branchlets equally dense, foliage also same, but fruit is looking more flat than the others. Measurements in Table 36.\*\*

This tree, as given in Table 36, has decidedly flat fruits, so that the flatness of fruit in Kogakei-Zairai ranges from 1.33 to 1.47, as far as our measurements are concerned. The fruit taken from one limb like

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\* PL. IV, Fig. 4.

\*\* PL. V, Fig. 3.

TABLE 35.

MEASUREMENT OF KOGAKEI FRUITS OF SATSUMA ORANGE, FROM INDIVIDUAL EAST OF LOT NO. 8 OF 1919 AND LOT NO. 37 OF 1920. TOTAL NUMBER OF FRUITS, 29 (NO. 965-993), FROM A SINGLE BRANCH.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.08 cm.	4.44 cm.	1.37	86.34 gm.	10.62 mm.	10.79	2.67 mm.	12.98 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	29	—	—	—	—	—	18	% 62.07
Sinuate based fruits	29	—	—	—	—	—	15	51.73
Semi-sinuate based fruits (included in the fore- going)		(not observed)						
Areolated fruits	29	—	—	—	—	—	23	79.31
Frs. with undeveloped calyx lobes	29	—	—	—	—	—	9	31.03
Frs. with long narrow calyx lobes	29	—	—	—	—	—	0	0
Fruits containing seeds	29	—	—	—	—	—	0	0
Apical depression	29	0 0	2 6.90	27 93.10	0 0%	—	—	—
Apical dots	29	3 10.34	7 24.14	19 65.52%	—	—	—	—
Flatness of fruit	29	0 0	5 17.24	20 68.97	4 13.79	0 0%	—	—
Smoothness of fruit	29	0 0	18 62.07	11 27.93	0 0	0 0%	—	—
Thinness of rind	29	15 51.72	13 44.83	1 3.45	0 0	0 0%	—	—
Thinness of segment wall	29	12 41.38	13 44.83	4 13.79	0 0	0 0%	—	—
Color of pulp	29	0 0	4 13.79	22 75.86	3 10.34	0 0%	—	—
Size of central column	29	0 0	5 17.24	20 68.97	4 13.79	0 0%	—	—
Quantity of pith	29	0 0	10 34.48	19 65.52	0 0	0 0%	—	—
Quality of pulp	29	1 3.45	7 24.14	19 65.52	2 6.90	0 0%	—	—

TABLE 36.

MEASUREMENT OF KOGAKEI FRUITS OF SATSUMA ORANGE, FROM INDIVIDUAL NORTH-EAST OF LOT NO. 8 OF 1919 AND LOT NO. 34 OF 1920. TOTAL NUMBER OF FRUITS, 19 (NO. 994-1012) FROM A SINGLE LIMB.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.14 cm.	4.74 mm.	1.42	109.00 gm.	10.42 mm.	10.99	3.04 mm.	14.95 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	19	—	—	—	—	—	10	% 52.63
Sinuate based fruits	19	—	—	—	—	—	17	89.47
Semi-sinuate based fruits (included in the foregoing)		(not observed)						
Areolated fruits	19	—	—	—	—	—	3	15.79
Frs. with undeveloped calyx lobes	19	—	—	—	—	—	10	52.63
Frs. with long narrow calyx lobes	19	—	—	—	—	—	0	0
Fruits containing seeds	19	—	—	—	—	—	2	10.53
Apical depression	19	0 0	8 42.11	11 57.89	0 0%	—	—	—
Apical dots	19	0 0	0 0	19 100.00%	—	—	—	—
Flatness of fruit	19	9 47.37	9 47.37	1 5.26	0 0	0 0%	—	—
Smoothness of fruit	19	0 0	5 26.32	12 63.16	2 10.53	0 0%	—	—
Thinness of rind	19	4 21.05	10 52.63	5 26.32	0 0	0 0%	—	—
Thinness of segment wall	19	10 52.63	6 31.58	3 15.79	0 0	0 0%	—	—
Color of pulp	19	2 10.53	10 52.63	4 21.05	2 10.53	1 5.26%	—	—
Size of central column	19	0 0	1 5.26	16 84.21	2 10.53	0 0%	—	—
Quantity of pith	19	0 0	9 47.37	10 52.63	0 0	0 0%	—	—
Quality of pulp	19	1 5.26	9 47.37	8 42.11	0 0	1 5.26%	—	—



this lot, may tend to include larger fruits than the average, but this seemed to be clearly avoided by taking samples properly. Base of the fruit depressed and grooved, apex is flattened or slightly depressed, and outline more or less fluted. Texture of rind is hard, oily, clinging to the pulp ball and is more or less warty, looking as though durable in storage. Rind and segment wall rather thin, central column medium-sized, pith medium abundant, and the quality of pulp is much better.

The difference between these three individuals is slight, and it can be easily concluded that they belong to the same variety. They may have come from the same individual—an old plant in Koga village, as stated before. It is also clear that the Zairai may have rather flat fruit, but the quality is far inferior to the average Ikiriki Owari or the Owari trees from other localities.

### SELECTED INDIVIDUALS OF IKIRIKI-OWARI

With the progress of field work in Ikiriki village, the author laid stress upon the discovery of selected individual plants bearing large, excellent fruits. After an active survey, a tree was located in 1919 which satisfied this aim. This was found in the orchard of Motarô TANAKA, in Funatsu-gô, Ikiriki proper. It is a well known story that the fruit of Kashima and Sase Sections of the village, is the best, and both have the same history of planting. The island of Kashima was the private property of the feudal lord of Ômura, before the Meiji restoration, and there were choice individuals of the Satsuma orange, which were especially tended for the table use of His Highness. Sase planting is said to be based upon these Kashima plants, while plants raised commonly in Ikiriki proper are not of the same clan. It was found, however, that a few trees of the Kashima clan are in existence in Mr. TANAKA's orchard, as one of the members of this family was acquainted with the keeper of the property, by whom a few budwoods of the selected individual were given secretly. There are several second and third generation trees propagated from the plants grown up from these buds, and these plants are credited as having an excellent crop of remarkable quality. The repre-

sentative tree chosen for the investigation was a medium-sized 20 year old individual, propagated by Motoemon TANAKA, father of the present owner. The details of the tree and the condition of the orchard are given below :

Lot No. 6 of 1919. "Kashima" Ikiriki (Owari) in TANAKA's orchard, planted on a moderate slope standing in a single row 3.5 m. apart from other trees. The tree is on the 2nd terrace below the road, the third tree from the west, with E-W spread 3.2 m., N-S spread 4.35 m., height 2.3 m. The base of the tree is divided into three trunks, head of the tree is round, branches moderately spreading, branchlets not drooping. Leaves medium-large, broad, more or less boat-shaped, not hanging. Soil rather fertile ; fertilizer constitutes of a mixture of rice bran and fish manure, 4 shô (7.3 litres) being applied per tree. Fruits are picked about December 10th, and are stored until very late. The measurements of fruits are given in Table 37.\*

The figure of the table shows how remarkable this individual is. Although the flatness and smoothness of fruit is not very pronounced, the skin is very tight, apex not much depressed, with convex dots reaching to the blossom end, the areola not developing. The calyx is large, with a small percentage of individuals having undeveloped lobes but more occasionally with long, sepal-like ones. Navel marking is fairly well developed. In cross-section, the rind is medium-thin, but not very thin, though the segment wall is very markedly thin. Size of central column and the amount of pith are medium and the color of pulp is exceedingly deep. The quality of pulp is first class, and the best among the 1919 lots, with the exception of YAKUSHIJÛ's Hira (Lot No. 24, Table 46). In addition to these statistical figures, the qualitative characters, such as the solid and fine-grained pulp of wonderful keeping quality, and the very elastic, extremely bright-colored rind, gave the highest mark to this lot.

In the succeeding year (1920), the tree, Lot No. 6 was in very bad condition due to an attack of the devastating scale insect, *Prontaspis*

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\* PL. VII, Fig. 1.

TABLE 37.

MEASUREMENT OF SATSUMA FRUITS OF "KASHIMA" IKIRIKI OF OWARI VARIETY, FROM THE ORCHARD OF M. TANAKA IN IKIRIKI.  
LOT NO. 6 OF 1919. TOTAL NUMBER OF FRUITS, 588

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.93 cm.	4.35 cm.	1.39	84.80 gm.	—	10.88	2.49 mm.	11.90 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	588	—	—	—	—	—	335	% 56.97
Sinuate based fruits	583	—	—	—	—	—	13	2.25
Semi-sinuate based fruits	—	—	—	—	—	—	—	12.59
Areolated fruits	598	—	—	—	—	—	74	22.33
Frs. with undeveloped calyx lobes	318	—	—	—	—	—	81	4.09
Frs. with long narrow calyx lobes	318	—	—	—	—	—	13	11.56
Fruits containing seeds	588	—	—	—	—	—	68	—
Apical depression	583	50 8.58	98 16.81	189 32.42	246 42.20%	—	—	—
Apical dots	536	4 0.75	34 6.34	498 92.91%	—	—	—	—
Flatness of fruit	582	134 23.02	299 51.37	142 24.40	7 1.20	0 0%	—	—
Smoothness of fruit	586	27 4.61	238 40.61	188 32.08	88 15.02	45 7.68%	—	—
Thinness of rind	581	382 65.76	147 25.30	35 6.02	13 1.89	7 1.03%	—	—
Thinness of segment wall	580	532 91.72	43 7.41	4 0.49	1 0.17	0 0%	—	—
Color of pulp	580	517 89.14	63 10.86	0 0	0 0	0 0%	—	—
Size of central column	571	4 0.70	20 3.50	397 69.53	106 18.56	44 7.71%	—	—
Quantity of pith	578	1 0.17	22 3.81	387 66.96	246 25.26	22 3.81%	—	—
Quality of pulp	550	355 64.35	132 24.00	52 9.45	11 2.00	0 0%	—	—

*yanonensis*, and it was not possible to study the fruits again, but the plant was successfully propagated at the Hiroshima-ken Citrus Station at Ôchô. To make a comparative study of other individuals prevalent in the vicinity, a tree was chosen and a limb was selected to furnish a total crop for measurement. This tree is located at the top of TANAKA's orchard, at the south-eastern corner, not far from the house, and it was about 40 years old. The origin of this tree was not definitely known, and was judged to be a Kogakei having a fluted surface, like MIZOMOTO's plants studied before (Table 33-36).

The fruits picked from the tree were rather deeply depressed at the stem-end, broadly grooved and irregularly fluted. The rind was rough, hard, and brittle, but apparently it was durable and keeps long. The condition of the fruit was almost ripe and there were a few scabby fruits among them. The measurements of the lot are given in Table 38.\*

The figure in the table shows that it is entirely different from the previous tree (Table 37), so different that it requires no comparison. The fruit is flat, but does not look so on account of its high shoulder. Apical depression is very little but sinuous; round based fruits are also very few. Although the areola is fairly prevalent, dots reach to the styler point to a large extent. Fruit is more rough, thicker skinned, thicker walled, lighter colored, but pith is not abundant. Quality of pulp is exceedingly poor in comparison with the preceding. This is nothing but an ordinary Kogakei (fluted type), as seen in MIZOMOTO's orchard and in the Nakagawa Station.

#### *Selected individuals in the Sase section of Ikiriki*

As is stated before, good individual trees must exist in Sase, because the budwoods of the Lord of ÔMURA's select trees in Kashima Island must have reached there, as previous information indicates, for the island is on the boat route from Ikiriki proper to this isolated place, which must have been touched occasionally *en route*, giving an ample chance for

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\* PL. VI, Fig. 3.

TABLE 38.

MEASUREMENT OF SATSUMA FRUITS FROM A LIMB OF TANAKA'S TREE OF KOGAKEI IN IKIRIKI. LOT NO. 33 OF 1920. TOTAL NUMBER OF FRUITS, 50 (NOS. 825-874).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.27 cm.	4.63 cm.	1.47	98.66 gm.	10.18 mm.	10.16	2.84 mm.	13.11 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	50	—	—	—	—	—	11	22.00%
Sinuate based fruits	50	—	—	—	—	—	9	18.00
Semi-sinuate based fruits		(not observed)						
Areolated fruits	50	—	—	—	—	—	19	38.00
Frs. with undeveloped calyx lobes	50	—	—	—	—	—	23	46.00
Frs. with long narrow calyx lobes	50	—	—	—	—	—	0	0
Fruits containing seeds	49	—	—	—	—	—	1	2.04
Apical depression	50	0 0	22 44.00	22 44.00	6 12.00%	—	—	—
Apical dots	50	0 0	6 12.00	44 88.00%	—	—	—	—
Flatness of fruit	50	3 6.00	33 66.00	12 24.00	2 4.00	0 0%	—	—
Smoothness of fruit	50	0 0	1 2.00	32 64.00	17 34.00	0 0%	—	—
Thinness of rind	49	24 49.00	18 36.72	6 12.24	1 2.04	0 0%	—	—
Thinness of segment wall	49	17 34.70	23 46.94	8 16.32	1 2.04	0 0%	—	—
Color of pulp	49	8 16.32	29 59.19	10 20.41	2 4.08	0 0%	—	—
Size of central column	49	3 6.12	11 22.45	25 51.02	10 20.41	0 0%	—	—
Quantity of pith	49	0 0	12 24.49	33 67.35	4 8.16	0 0%	—	—
Quality of pulp	49	3 9.12	14 28.57	26 53.06	4 8.16	2 4.08%	—	—

securing the forbidden bud sticks. Most of the attentive seekers for a good strain of the Satsuma orange missed this isolated region, and even the dwellers of Ikiriki proper have very little knowledge about Sase plants.

With the efficient assistance of the late Mr. Seita HAMADA of the Nagasaki Experiment Station, the writer made a survey of this section in 1920 and succeeding years, and it became very clear that the expectation was quite correct, and many such individuals of the highest grade do exist in this section. As the result of field investigations, an individual of supreme rank was discovered in the orchard of Shintarô MATSUO, the individual is apparently the best of all the common Satsumas ever noticed by the writer throughout the period of the investigation. The description of this tree is given as follows:

Lot No. 29 and 30 of 1920. MATSUO's Sase Nakashima (Ikiriki-Owari), in the orchard of Shintarô MATSUO (later the property of his son, Keisaku MATSUO and at present of his grandson, Matsujirô MATSUO), at Hyakkoku, Kiba, Sase-gô, Ikiriki village (PL. XLVIII, Fig. 1). It is a large tree about 25 years old, standing in a high, broad terrace, lower row, 2nd tree from south, trees planted about 3.5 m. apart (north tree lacking). E-W spread of the tree 3.5 m., N-S spread 3.5 m., height 2.6 m., girth of trunk above the union 53 cm. Branches wide open, spreading southward, thick, appearing somewhat like a shaddock tree. Leaves extremely large and broad, hanging. Soil rich loam, reddish, with angular gravel, straw-mulched, fertilizers consist of rape seed cake, bean cake, stable manure, and night soil, applied in an amount valued at about 30 yen per tan (303 yen per hectare). The measurements of the fruits are given in Table 39.\*

The fruit is extremely large, ranging from very large to medium, and the shape is medium-flat (depressed globose) with rounded shoulder, very regular in outline. Apical depression slight but distinct with not much developed areola; navelled fruits rather frequent. Base not strongly depressed, only gradually concave and rather faintly grooved. Calyx

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\* PL. VII, Fig. 2.

TABLE 39.

MEASUREMENT OF FRUITS OF MATSUO'S LARGE-FRUITED SASE NAKASHIMA  
(OWARI SATSUMA) FROM IKIRIKI. LOT NO. 29 & 30. TOTAL NUMBER  
OF FRUITS, 164 (NOS. 1064-1071, 5306-5466).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
23.11 cm.	5.18 cm.	1.42	137.50 gm.	11.69 mm	10.06	3.43 mm.	16.30 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	164	—	—	—	—	—	78	% 47.56
Sinuate based fruits	164	—	—	—	—	—	4	2.44
Semi-sinuate based fruits	164	—	—	—	—	—	20	12.19
Areolated fruits	164	—	—	—	—	—	92	56.10
Frs. with undeveloped calyx lobes	164	—	—	—	—	—	21	12.80
Frs. with long narrow calyx lobes	164	—	—	—	—	—	8	4.88
Fruits containing seeds	158	—	—	—	—	—	6	3.80
Apical depression	164	21 12.80	54 32.93	74 45.12	15 9.15%	—	—	—
Apical dots	164	17 10.37	55 33.54	92 56.09%	—	—	—	—
Flatness of fruit	161	33 20.50	77 47.83	50 31.06	1 0.62	0 0%	—	—
Smoothness of fruit	160	1 0.63	43 26.88	97 60.63	19 11.88%	—	—	—
Thinness of rind	160	53 33.13	48 30.00	55 34.33	3 1.88	1 0.63%	—	—
Thinness of segment wall	160	103 64.38	42 26.25	12 7.50	3 1.88	0 0%	—	—
Color of pulp	160	152 95.00	8 5.00	0 0	0 0	0 0%	—	—
Size of central column	158	1 0.63	3 1.90	85 53.80	62 39.24	7 4.43%	—	—
Quantity of pith	159	1 0.63	2 1.26	103 64.78	40 25.16	13 8.18%	—	—
Quality of pulp	158	121 76.58	34 21.52	3 1.90	0 0	0 0%	—	—

very large, with very well developed, deep green lobes, disk concealed. Surface moderately harshed and convex-dotted but not rough, compact, turgid, oily. In cross-section, rind is moderately thin, segment wall rather conspicuously thin, and the central column medium or medium-small, with rather reduced amount of pith. Pulp very deep-colored and very intensely sweet and of excellent quality. Some fruits were kept until very late without deterioration.

This remarkable individual of an Ikiriki-Owari has since been extensively propagated as one of the mother trees of the standard Satsuma, certified by the prefecture. In the year 1924, this tree was again investigated to find out if the superiority is still retained or not. Although the infection of *Prontaspis* scale was pretty bad, the total crop of one branch of the same tree was picked and used for the study. It was said that the fruit from this individual was awarded the first prize three time since the author's first discovery. Trees in the vicinity all seemed good, but this individual was still far superior to them. We were informed that the fruits are picked at about the 23rd of December, and are sold at 9.50 yen per 100 kin (15.83 yen per 100 kg.), a price very much higher than that for ordinary Satsumas. Fertilizer of 3 shô (5.5 litres) of rape seed cake, and an equal amount of rice bran were used in 1923. There was a crop of about 200 kwan (750 kg.) in the same year.

The fruits in 1924 looked quite uniform and true to type, but owing to the bad condition of the tree, they were rather few and more or less scabby. Despite this handicap, fruits collected showed good size and were tight-skinned, though a rather large amount of culls was inevitable. The typical fruits were flat and smooth, flattened at the base and not grooved. The apex was also simply flattened, rind elastic and durable, with a large percentage of convex oil cell dots. Calyx was large and occasionally looked more or less like that of the Wase Satsuma. These typical fruits have a small central column, soft and very finely grained pulp, which is deep-colored, extremely sweet, and keeps an extremely long period. The fruits were picked on January 10, but none of the fruit was puffy. The measurements of the fruits are recorded in Table 40.\*

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\* PL. VIII, Fig. 1.



TABLE 40.

MEASUREMENT OF FRUITS OF MATSUO'S LARGE-FRUITED SASE NAKASHIMA  
(OWARI SATSUMA) IN 1924. (SAME TREE AS LOT NO. 29-30). TOTAL  
NUMBER OF FRUITS, 56 (NOS. 7707-7762).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.96 cm.	5.21 cm.	1.34	133.04 gm.	10.48 mm.	10.71	3.17 mm.	14.29 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	56	—	—	—	—	—	21	37.60
Sinuate based fruits	56	—	—	—	—	—	6	10.72
Semi-sinuate based fruits	56	—	—	—	—	—	3	5.36
Areolated fruits	56	—	—	—	—	—	1	1.79
Frs. with undeveloped calyx lobes	56	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	56	—	—	—	—	—	0	0
Fruits containing seeds	56	—	—	—	—	—	1	1.79
Apical depression	56	0 0	11 19.64	36 64.29	9 16.07%	—	—	—
Apical dots	56	0 0	14 25.00	42 75.00%	—	—	—	—
Flatness of fruit	56	20 35.71	19 33.93	11 19.64	3 5.36	3 5.36%	—	—
Smoothness of fruit	56	0 0	36 64.29	18 32.14	2 3.57	0 0%	—	—
Thinness of rind	56	16 28.57	28 50.00	11 19.64	1 1.79	0 0%	—	—
Thinness of segment wall	56	23 41.07	31 55.36	2 3.57	0 0	0 0%	—	—
Color of pulp	56	51 91.07	5 8.93	0 0	0 0	0 0%	—	—
Size of central column	56	2 3.57	9 16.07	32 57.14	12 21.43	1 1.79%	—	—
Quantity of pith	56	0 0	11 19.64	42 75.00	3 5.36	0 0%	—	—
Quality of pulp	43	38 88.37	5 11.63	0 0	0 0	0 0%	—	—

The figure in the table shows a remarkable similarity with that of Table 39, the fruit measured in 1920, four years before. The remarkable individuality of MATSUO's "Sase Nakashima" is, therefore, definitely established.

There is another remarkable individual in the orchard neighbouring MATSUO's. It belongs to Tsunetarô YAMADA, and is about 60 years of age. It looks almost as good as the "Sase Nakashima" individual recorded above. This tree (Prefecture No. 4) is a large-sized, hemispherical, well branched individual with large, hanging, but not undulate, leaves. The fruits were few when observed in 1924, but they were very large-sized and of remarkably good flavor. It was not used for the individuality test because it was considered as belonging to the same clan as the former.

### ADDITIONAL STUDY IN IKIRIKI-OWARI

As is discussed in the previous chapter, the best individuals of the Ikiriki-Owari have their common origin in the Satsumas of Kashima Island. The actual survey in the island showed that such special individuals were not uncommon, though they do not belong to the Lord of Ômura any longer. A tree of apparently the same nature was chosen for individuality investigation from an orchard of Kunisaku HIRAKIDA. The description of this tree is given as follows:

Lot No. 31-32 of 1920. An old tree about 50 years of age in the orchard of Kunisaku HIRAKIDA, Kashima-gô, Ikiriki village, being a single tree standing in a vegetable garden, one half weakened by disease. Upright habit, E-W spread 7 m., N-S spread 7 m., height 3.5 m., branches not abundant, straight, very erect and upright; leaves on weakened portion numerous, small, erect, and boat-shaped, those on healthy part large and hanging. Fruit on tree very large-sized, smooth, glazed, and flat. The soil of the orchard is red and contains no pebbles; night soil and stable manure, with a mixture of wood ash, are applied after the fruits are picked; no mulch. The tree was propagated by Iwaemon HIRAKIDA, father of the present owner, who used the local budwood produced in

the island. This is perhaps the oldest tree now in existence in the island. The measurements of the fruits are given in Table 41.\*

All the fruits used for the study were large and more or less regular in outline; rind was elastic, oily, compact, oil cell dots being distinctly both convex and concave. Stem-end grooved but not very conspicuously deep-concave, navel prominent, areola also very prominent, calyx medium-sized. The fruit was in full maturity when handled to take outside measurements, and the skin was tight, but later it showed a slight puffiness after a long period of storage and then the inside measure was taken. The fruits were scabby and more or less sooty.

The figure in the table shows a general agreement with that of MATSUO's in respect to size, characters of both ends, the rind and segment wall, central column and amount of pith. The remarkable flatness almost matches the Hira, but in this lot both ends are more depressed and the surface is more roughly pitted. The section of fruit was very regular, as in other Ikiriki-Owari, rind thin, segment wall thin but elastic, not readily broken, central column medium-sized. Pulp deep-colored, meaty, excellent flavor, vesicles anastomose, with strong wall. Amount of pith is medium or little. It is remarkable that the quality of fruit almost equals that of MATSUO's "Sase Nakashima" individual and excels TANAKA's "Kashima" individual of the previous year. This gives a sufficient basis to the general reputation that the Satsuma of Kashima Island is excellent, and that the best individuals growing in Ikiriki proper came from this island.

It is, however, worthy of note that the plants of Kashima Island do not represent a single variety, Ikiriki-Owari, only, but as is naturally expected, the Kogakei-Zairai is also found reaching this island. Such a tree of an entirely different origin is well recognized by the inhabitants of the island, and they know that it comes from Koga village. One of Kogakei trees in HIRAKIDA's orchard was chosen for the purpose of comparing it with the Ikiriki-Owari, to determine if there is any remarkable difference between them. The description of this individual is given in the following paragraph.

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\* PL. VIII, Fig. 2.

TABLE. 41.

MEASUREMENT OF FRUITS OF HIRAKIDA'S OLD SATSUMA TREE IN KASHIMA  
ISLAND REPRESENTING SUPERIOR IKIRIKI (OWARI) VARIETY. LOT  
NO. 31-32, 101 FRUITS. (NOS. 1066-1071, 5111-5205).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.70 cm.	4.75 cm.	1.52	122.20 gm.	10.28 mm.	10.68	2.87 mm.	17.31 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	101	—	—	—	—	—	62	61.39
Sinuate based fruits	101	—	—	—	—	—	1	0.99
Semi-sinuate based fruits	101	—	—	—	—	—	3	2.97
Areolated fruits	101	—	—	—	—	—	85	84.16
Frs. with undeveloped calyx lobes	100	—	—	—	—	—	22	22.00
Frs. with long narrow calyx lobes	100	—	—	—	—	—	1	1.00
Fruits containing seeds	100	—	—	—	—	—	51	51.00
Apical depression	110	10 9.90	69 68.32	21 20.79	1 0.99	—	—	—
Apical dots	101	2 1.98	53 52.48	46 45.54%	—	—	—	—
Flatness of fruit	101	53 52.48	37 36.63	10 9.90	1 0.99	0 0%	—	—
Smoothness of fruit	101	0 0	6 5.94	88 87.13	7 6.93	0 0%	—	—
Thinness of rind	100	60 60.00	29 29.00	11 11.00	0 0	0 0%	—	—
Thinness of segment wall	100	56 56.00	23 23.00	20 20.00	1 1.00	0 0%	—	—
Color of pulp	95	71 74.74	20 21.05	4 4.21	0 0	0 0%	—	—
Size of central column	100	1 1.00	20 20.00	67 67.00	12 12.00	0 0%	—	—
Quantity of pith	100	0 0	10 10.00	67 67.00	18 18.00	5 5.00	—	—
Quality of pulp	95	67 72.63	19 20.00	7 7.37	0 0	0 0%	—	—

Lot No. 63 of 1920. HIRAKIDA's Kogakei Satsuma. Located in the south-eastern orchard, left of the road, the first (in the S-E corner) of seven trees, 3.5 m. away from the eastern tree, 2.6 m. from the northern, having its own E-W spread 4.35 m., N-S spread 4.35 m., and height 2.6 m. It is an unpruned tree of open habit, branches are straight, leaves narrow, boat shaped, dense, not hanging nor undulate. Fruits on tree large and round. The crop of one branch was used for study. The measurements of the fruits are given in Table 42.\*

The fruit of this lot was large, mostly truncate, compact and roughly pitted, outline rather regular, surface oily, with convex and concave dots giving a rough appearance. Base not much depressed, frequently sinuate, much grooved. Calyx rather small, lobes more or less imperfectly lobed, thin, easily change color. Apex rather depressed, navel not well developed, areola strongly developed, often with double rings and enclosed concave area becoming excavated. Almost no blemish, tight-skinned. In cross-section, rind rather thick, segment outer wall undulate, corner rounded, rather adherent to the rind. Central column small, segment pointed at this end, pith rather little in amount. Oil cells of the rind often very large, inflated, close together. Pulp deep-colored, fair quality, finely grained, meaty, not melting, vesicles rather stretched, thin walled, inseparable. These features give a very different impression of the fruit, in comparison with the Ikiriki-Owaris described before, and proved it to be identical to the Kogakei-Zairai Satsuma at the Nakagawa Station (Lot No. 1) and BUTÔ's orchard (Lot Nos. 23 and 62).

*Ikiriki-Owari on sour stock*

With the advance of the work in Kashima Island, off Ikiriki proper a large tree of Ikiriki-Owari on sour-orange stock was found in an orchard of Ihei KITaura. This is the only Satsuma tree on Japanese sour stock the author ever found. This was an Ikiriki (Owari) variety but the variation in fruit characters seemed to be fairly large, due to the influence

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\* PL IV, Fig. 1.

TABLE 42.

MEASUREMENT OF SATSUMA FRUITS OF HIRAKIDA'S KOGAKEI FOUND IN  
KASHIMA ISLAND OFF IKIRIKI. LOT NO. 63 OF 1920. TOTAL  
NUMBER OF FRUITS, 50 (NOS. 5206-5255).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.60 cm.	4.76 cm.	1.37	98.52 gm.	9.72 mm.	10.68	3.57 mm.	14.86 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	50	—	—	—	—	—	13	% 26.00
Sinuate based fruits	50	—	—	—	—	—	10	20.00
Semi-sinuate based fruits	50	—	—	—	—	—	5	10.00
Areolated fruits	50	—	—	—	—	—	48	96.00
Frs. with undeveloped calyx lobes	50	—	—	—	—	—	18	36.00
Frs. with long narrow calyx lobes	50	—	—	—	—	—	4	8.00
Fruits containing seeds	50	—	—	—	—	—	15	30.00
Apical depression	50	15 30.00	19 38.00	16 32.00	0 0%	—	—	—
Apical dots	50	4 8.00	26 52.00	20 40.00%	—	—	—	—
Flatness of fruit	50	0 0	9 18.00	30 60.00	10 20.00	1 2.00%	—	—
Smoothness of fruit	50	0 0	0 0	18 36.00	19 38.00	13 26.00%	—	—
Thinness of rind	50	2 4.00	6 12.00	17 34.00	18 36.00	7 14.00%	—	—
Thinness of segment wall	49	16 32.65	11 22.45	18 36.73	3 6.12	1 2.04%	—	—
Color of pulp	50	28 56.00	19 38.00	3 6.00	0 0	0 0%	—	—
Size of central column	50	0 0	1 2.00	34 68.00	9 18.00	6 12.00%	—	—
Quantity of pith	50	2 4.00	6 12.00	30 60.00	8 16.00	4 8.00%	—	—
Quality of pulp	50	12 24.00	23 46.00	15 30.00	0 0	0 0%	—	—

of the stock, so that it was thought worth while to carry out an individuality test. The description of the tree is as follows :

Lot No. 28 of 1920. Ikiriki Satsuma on sour stock, in front of the house of Ihei KITAURA. Very large tree of about 40 years of age, with E-W spread 5.2 m., N-S spread 5.2 m., height 3.5 m. Branches dense, moderately spreading ; leaves broad, almost looking like those of Kunembo, boat-shaped. Propagator unknown. Fruits of one branch were used for study. The measurements of fruits are given in Table 43.\*

The fruit was large, medium or medium-flat, with rather regular outline. The surface was pitted but not strongly so on average, compact and oily. Apex only moderately depressed, areola present but not very conspicuous, navel prominent. Base depressed and grooved, calyx not markedly large and lobes often not well developed. Tight-skinned and no blemishes. The section has rather thin rind, medium-thin segment, medium or rather large central column with little amount of pith. Color of pulp was not intense and the quality of pulp was only fair. From this study, the stock influence seems primarily to affect the size and shape of leaves and fruit, and causes an insipidness of the pulp. The number of fruits is also reduced, but no other marked disadvantages were noticed.

### THE HIRA VARIETY AND ITS DISTINCTION FROM OTHER VARIETIES

Although the Hira variety is well established according to the study of previous years already stated, the author continued further investigations to confirm the results obtained before. KAGAYAMA's very old Hira plant mentioned before was in a very poor condition in 1919 (PL. XLVIII, Fig. 2), but since there were a sufficient amount of fruits on the tree, they were used for measurements, the figures of which are shown in Table 44.\*\*

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\* PL. VIII, Fig. 3.

\*\* PL. IX, Fig. 1.

TABLE 43.

MEASUREMENT OF IKIRIKI SATSUMA FRUITS (OWARI) ON SOUR STOCK AT  
KITAURA'S ORCHARD, KASHIMA OFF IKIRIKI. LOT NO. 28 OF 1920.  
TOTAL NUMBER OF FRUITS, 50 (NOS. 5256-5305).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.38 cm.	4.95 cm.	1.44	124.84 gm.	9.48 mm.	10.84	3.60 mm.	18.31 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	50	—	—	—	—	—	22	% 44.00
Sinuate based fruits	50	—	—	—	—	—	1	2.00
Semi-sinuate based fruits	50	—	—	—	—	—	7	14.00
Areolated fruits	50	—	—	—	—	—	42	84.00
Frs. with undeveloped calyx lobes	50	—	—	—	—	—	20	40.00
Frs. with long narrow calyx lobes	50	—	—	—	—	—	4	8.00
Fruits containing seeds	49	—	—	—	—	—	13	26.53
Apical depression	50	4 8.00	16 32.00	30 60.00	0 0%	—	—	—
Apical dots	50	0 0	15 30.00	35 70.00%	—	—	—	—
Flatness of fruit	50	12 24.00	23 46.00	14 28.00	1 2.00	0 0%	—	—
Smoothness of fruit	50	0 0	2 4.00	45 90.00	1 2.00	2 4.00%	—	—
Thinness of rind	49	7 14.29	27 55.10	14 28.57	0 0	1 2.04%	—	—
Thinness of segment wall	49	23 46.93	21 42.86	4 8.16	1 2.04	0 0%	—	—
Color of pulp	49	21 42.86	25 51.02	3 6.12	0 0	0 0%	—	—
Size of central column	49	1 2.04	11 22.45	34 69.39	3 6.12	0 0%	—	—
Quantity of pith	49	0 0	0 0	30 61.22	18 36.73	1 2.04%	—	—
Quality of pulp	48	11 22.92	22 45.83	15 31.25	0 0	0 0%	—	—



TABLE 44.

MEASUREMENT OF FRUITS OF HIRA SATSUMA FROM THE OLDEST TREE IN  
KAGAYAMA'S ORCHARD, AT TACHIMA, EHIME-KEN. LOT NO. 9  
OF 1919. TOTAL NUMBER OF FRUITS, 249.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.64 cm.	3.74 cm.	1.50	57.62 gm.	—	10.19	2.45 mm.	12.33 cm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	249	—	—	—	—	—	4	1.61%
Sinuate based fruits	249	—	—	—	—	—	121	48.60
Semi-sinuate based fruits		(not observed)						
Areolated fruits	249	—	—	—	—	—	63	25.30
Frs. with undeveloped calyx lobes	80	—	—	—	—	—	26	32.50
Frs. with long narrow calyx lobes	80	—	—	—	—	—	1	1.25
Fruits containing seeds	249	—	—	—	—	—	25	10.04
Apical depression	245	20 8.16	61 24.90	120 48.98	44 17.96%	—	—	—
Apical dots	240	10 4.17	77 32.08	153 63.75%	—	—	—	—
Flatness of fruit	249	147 59.04	87 34.94	15 6.02	0 0	0 0%	—	—
Smoothness of fruit	248	166 66.94	69 27.82	7 2.82	2 0.81	4 1.61%	—	—
Thinness rind	248	60 24.19	78 31.45	65 26.21	23 9.27	22 8.87%	—	—
Thinness of segment wall	248	52 20.97	75 30.24	51 20.56	52 20.97	18 7.26%	—	—
Color of pulp	247	42 17.00	105 42.51	61 24.70	39 15.79%		—	—
Size of central column	249	32 12.90	70 28.23	138 55.65	8 3.23	0 0%	—	—
Quantity of pith	247	53 21.46	114 46.15	79 31.98	1 0.40	0 0%	—	—
Quality of pulp	234	15 6.41	66 28.21	89 38.03	40 17.09	24 10.26%	—	—

As the tree was nearly dying, the fruits were considerably small, very light-colored, extremely smooth, very typically flat as seen before. Basal sinuation was rather pronounced since the button was very tight, and no broad depression was caused by the checked growth of the rind. In cross-section, the rind was not very thin, being very brittle, segment wall considerably thick, color of pulp very light, central column considerably large with abundant quantity of pith, and the taste of pulp bitterish and very poor, showing distinct disintegration of constituents, due to the abnormal condition of the tree. It is remarkable that the fruits stay so flat notwithstanding the fact that other characters are so markedly deteriorating. The result obtained gave a very important suggestion that proves (1) Hira is unquestionably a very flat variety, (2) and that unusual conditions of the tree cause the deterioration of fruit, affecting the interior characters, as well as the quality of the pulp.

This plant was eventually cut down in the autumn of 1919, and it was found impossible to find an adequate substitute tree of an equal size and age, due to the bad condition of the orchard through a severe infection of the greasy spot disease.

It was necessary, however, to detect if there is any other variety besides Hira existing in the Tachima district. Unconfirmed information tells that there was an introduction of Satsuma plants about 120 years ago (from 1920) from Tosa Province, and unquestionably either Zairai or Owari varieties must exist among very old trees still living in the village. Mr. KAGAYAMA indicated an old tree in his orchard to be of such origin. There was another tree of about the same age and a dead stump of about the same size was also lying among these trees. The living trees were in a bad condition, being seriously injured by the greasy spot disease, but the southern tree, looking better than the others, was used for the study of the fruit. The description of this individual is given below :

Lot No. 38. KAGAYAMA's tree, about 80 years old, in Hagio, west of Shiraidani, in Tachima village. Although weakened by disease, the tree was bearing a full crop, and a terminal branch was completely picked for study. It stands on a slope inclined toward the south-east, above a mulberry plantation, with E-W spread of 7.4 m., N-S spread 7.8 m., and

height 5.2 m. General behavior of the tree is like Owari, well spreading, branch ends drooping, number of shoots very few, twigs somewhat contorted. Leaves much weakened by the greasy spot disease, acutely pointed, slender, crowded-looking. Fruits on tree rather small, very much graded in size. Soil fertility rich, graveled loam; fertilizer used consists of fish manure, bean cake, and so on. Coloring season is about the middle of November, being rather early; fruit sold at a good price. This plant has three thick trunks of 46, 65 and 60 cm. girth, respectively. The trunk measurements of the other trees are, 36, 66 and 66 cm., respectively. Girth of forked trunks of the dead stump, 76 and 53 cm., respectively. The measurements of fruits are given in Table 45.\*

The fruit is rather flat, both ends rather deeply depressed, not so compact as Hira, surface not very smooth, oily, navel less marked. Oil cell dots are large and crowded, calyx not large, more or less crater-like base distinct. The outline is not fluted but is more or less uneven. In cross-section, rind is rather thick, segment wall medium-thin, tenacious, pulp not fully colored yet but soft and very juicy. Central column medium-sized, pith rather less than medium. Number of segments fluctuating from 9 to 12, rind rather raggy and oily. Pulp still acidulous and not intense in taste. General characters agree very closely with those of the Owari variety, and, judging from the fact that an enormous quantity of Owari nursery plants have been distributed by Mr. KAGAYAMA, a tree like this must have supplied bud sticks. The other individual with similar characters is also considered to be one of the parent trees from which propagations have been made from a long period in the past.

*Progeny of Hira plant which existed in Kagayama's orchard*

As was stated in the last chapter, the aged Hira tree in KAGAYAMA's orchard is concluded to be one of the progenitors of the Hira variety known only in Tachima village. It is then very necessary to locate the

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\* PL. IX, Fig. 2.

TABLE 45.

MEASUREMENT OF FRUITS OF KAGAYAMA'S OLD SATSUMA TREE APPARENTLY  
OWARI VARIETY, AT TACHIMA. LOT NO. 38 OF 1920. TOTAL  
NUMBER OF FRUITS, 97 (NOS. 442-538).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.28 cm.	4.03 cm.	1.48	72.67 gm.	10.21 mm.	10.91	2.42 mm.	11.12 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	97	—	—	—	—	—	21	21.65%
Sinuate based fruits	97	—	—	—	—	—	3	3.09
Semi-sinuate based fruits	97	—	—	—	—	—	29	29.90
Areolated fruits	97	—	—	—	—	—	65	67.01
Frs. with undeveloped calyx lobes	95	—	—	—	—	—	17	17.90
Frs. with long narrow calyx lobes	95	—	—	—	—	—	0	0
Fruits containing seeds	97	—	—	—	—	—	11	11.34
Apical depression	97	85 89.63	10 10.31	2 2.06	0 0%	—	—	—
Apical dots	97	33 34.02	52 53.61	12 12.37%	—	—	—	—
Flatness of fruit	97	69 71.13	21 21.65	7 7.22	0 0	0 0%	—	—
Smoothness of fruit	97	27 27.84	61 62.88	9 9.28	0 0	0 0%	—	—
Thinness of rind	97	45 46.39	45 46.39	7 7.22	0 0	0 0%	—	—
Thinness of segment wall	97	56 57.33	40 41.24	1 1.03	0 0	0 0%	—	—
Color of pulp	97	3 3.09	50 51.55	42 43.30	2 2.06	0 0%	—	—
Size of central column	97	0 0	8 8.25	80 82.49	9 9.28	0 0%	—	—
Quantity of pith	97	1 1.03	2 2.06	74 76.29	18 18.56	2 2.66	—	—
Quality of pulp	97	0 0	17 17.53	43 44.33	27 29.84	10 10.31%	—	—

descendants of the old individual to see if the characteristics of the variety are correctly transmitted by vegetative propagation.

Fortunately, Mr. Sôichi YAKUSHIJI gave a clue to KAGAYAMA's old Hira tree, because he had been receiving a number of nursery plants from the latter from a long time before, and it was considered quite certain that some of his plants represent the parental character very well. This was found correct when the author made a thorough investigation in his orchard. Many individuals in the planting were found definitely identical with KAGAYAMA's Hira and in order to present a definite proof of this, a representative plant was chosen among them; it was described as follows.

Lot No. 24 of 1919. YAKUSHIJI's Hira tree: The individual named "Gold Medal", standing on a single-row terrace, way up the steep slope of Nishinotani, Tachima village. It is a tree of about 15 years of age, planted 3.5 m. away from others, is well pruned and thrifty, with E-W spread, N-S spread, and height 1.7 m. each. The fruit of this tree was awarded the first prize at the Union Fruit Contest of Shikoku Provinces. The measurements of fruit are given in Table 46.\*

This table shows a remarkable flatness of the fruits. The rind is rather thin, the segment wall medium-thin, size of central column rather large and the amount of pith is more or less abundant. The pulp is deep-colored, and very excellent in quality.

In order to make the characteristics of this individual sufficiently clear, the study of the fruit was repeated in 1925. The description of the fruit is recorded below, and the measurements are tabulated in Table 47.\*\*

Lot No. 24 bis of 1925. Individual "Gold Medal" of YAKUSHIJI's Hira. Fruits ranging from very large to small, always flat with only a few exceptions of medium-flat fruits, apex usually broad concave or flattened, areola present but not strong, navel present or absent, oil cell dots generally reaching to the styler point. Base broadly concave and grooved, grooves shallow in those fruits, smaller than the average, not

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\* PL IX, Fig. 3.

\*\* PL IX, Fig. 4.

TABLE 46.

MEASUREMENT OF FRUITS OF YAKUSHIJI'S HIRA SATSUMA FROM TACHIMA VILLAGE. INDIVIDUAL "GOLD MEDAL". LOT NO. 24 OF 1919. TOTAL NUMBER OF FRUITS, 60 FROM ONE BRANCH.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.56 cm.	4.56 cm.	1.56	106.12 gm.	—	10.93	2.76 mm.	16.58 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	60	—	—	—	—	—	29	48.33
Sinuate based fruits	60	—	—	—	—	—	4	6.67
Semi-sinuate based fruits	60	—	—	—	—	—	1	1.67
Areolated fruits	60	—	—	—	—	—	19	31.67
Frs. with undeveloped calyx lobes	59	—	—	—	—	—	6	10.17
Frs. with long narrow calyx lobes	59	—	—	—	—	—	1	1.70
Fruits containing seeds	60	—	—	—	—	—	11	18.33
Apical depression	60	6 10.00	32 53.33	15 25.00	7 11.67%	—	—	—
Apical dots	60	1 1.67	4 6.67	55 91.67%	—	—	—	—
Flatness of fruit	60	59 98.33	1 1.67	0 0	0 0	0 0%	—	—
Smoothness of fruit	60	1 1.67	49 81.67	5 8.33	5 8.33%	—	—	—
Thinness of rind	57	45 78.95	10 17.54	0 0	2 3.51	0 0%	—	—
Thinness of segment wall	56	21 27.50	28 50.00	2 3.57	5 8.93	0 0%	—	—
Color of pulp	56	54 96.43	2 3.57	0 0	0 0	0 0%	—	—
Size of central column	52	4 7.69	24 46.15	21 40.38	3 5.77	0 0%	—	—
Quantity of pith	52	0 0	19 36.54	33 63.46	0 0	0 0%	—	—
Quality of pulp	55	45 81.82	8 14.55	2 2.64	0 0	0 0%	—	—

TABLE 47.

MEASUREMENT OF HIRA SATSUMA FRUITS, INDIVIDUAL "GOLD MEDAL" OF  
SŌICHI YAKUSHIJI OF TACHIMA VILLAGE, LOT NO. 24 BIS, TOTAL  
NUMBER OF FRUITS, 196 (NOS. 10012-10209).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.59 cm.	4.41 cm.	1.56	115.65 gm.	10.26 mm.	10.67	3.15 mm.	13.80 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	194	—	—	—	—	—	41	% 21.13
Sinuate based fruits	194	—	—	—	—	—	10	5.16
Semi-sinuate based fruits	194	—	—	—	—	—	10	5.16
Areolated fruits	194	—	—	—	—	—	90	46.39
Frs. with undeveloped calyx lobes	194	—	—	—	—	—	29	14.95
Frs. with long narrow calyx lobes	194	—	—	—	—	—	2	1.03
Fruits containing seeds	194	—	—	—	—	—	6	3.09
Apical depression	194	68 35.05	92 47.42	32 16.49	2 1.03%	—	—	—
Apical dots	194	4 2.06	57 29.38	133 68.56%	—	—	—	—
Flatness of fruit	194	98 50.52	67 34.54	29 14.95	0 0	0 0%	—	—
Smoothness of fruit	194	3 1.55	64 32.99	98 50.52	29 14.95	0 0%	—	—
Thinness of rind	194	37 19.07	110 56.70	44 22.68	3 1.33	0 0%	—	—
Thinness of segment wall	194	107 55.15	75 38.66	9 4.64	3 1.55	0 0%	—	—
Color of pulp	194	45 23.20	61 31.44	49 25.26	27 13.92	12 6.19%	—	—
Size of central column	194	3 1.55	35 18.04	112 57.73	33 17.01	11 5.67%	—	—
Quantity of pith	194	3 1.55	68 35.05	109 56.19	14 7.220	0 0%	—	—
Quality of pulp	—	—	—	—	—	— %	—	—

sunken at the calyx, quite typical of this variety. Calyx medium-sized, well-lobed. Surface roughly pitted in larger fruits, but quite smooth in medium and smaller fruits, sometimes extremely smooth. Oil cell dots fine, never very prominent and causing roughness by convexity. It is a beautiful looking orange. The picking season was a little too late, so that the larger fruits were coarse, though they were still compact and never became puffy. In cross-section, rind is medium-thin to thin, but not very thin, segment wall medium-thick to thin, also not very thin. Rind texture becomes somewhat brittle. Central column medium-sized, pith rather abundant, never little in amount. Pulp deep-colored, but not averaging so uniformly, juicy and good quality, quite soft and not meaty, melting. Many fruits stored until late were fermented because of improper way of storage, so that the measurement of the quality of the pulp was not taken. The brittle nature of the rind must be due to the larger amount of area other than the oil cell region. This character is rather disadvantageous, causing a larger percentage of breakage during transit and an easy infection by blue mould.

The result of the study of this individual of YAKUSHIJ's Hira variety encouraged a further interest in the superior types of this variety. In the year 1920, another individual of his orchard, which seemed extremely promising like the former, attracted the author's attention. This individual was provisionally named "Excelsior", and the description is given below :

Lot No. 49-50. Individual "Excelsior" of YAKUSHIJ's Hira variety. Located in Yomojiro orchard, standing on a very steep slope facing the east, about half way up the slope from the bottom, south of the middle path, 15 years old, propagated by Uhei NAKAJIMA of Ikeda district, using the budwood of Kingo KAGAYAMA of Tachima. Similar trees are rather scarce in this orchard. Planted 3 m. apart, with E-W spread 2.9 m., N-S spread 2.9 m., height 1.7 m., a rather spreading tree because of the weight of fruits but branches are straight and upright, few in number. Leaves extremely long and sharp pointed, straight and less undulate, margin recurved inward, color green and very healthy looking. Soil



clayey loam, rather poor in organic matter, not mulched. Herring manure and wood ash valued at 20 sen is applied to a tree. Fruits are sold at 5.00 yen per 10 kwan (8.33 yen per 100 kg.), and are kept on tree rather long to display to visitors, but are never exhibited at any fruit contest. Measurements of fruits are given in Table 48.\*

The result given in Table 48 is based upon a mixture of two picks made at an interval of two months, so that the quality of fruit is inevitably very variable. There were no subacid fruits when the second pick was examined in January, 1921, and the fruit of Class 1 was 58.26%.

Fruits were medium in size, regularly depressed-globose with very regular outline, surface smooth, slightly pitted, bright colored, base slightly depressed, apex considerably flat, calyx large-sized, uniformly developed and rather light-colored, areola not pronounced. In cross-section, rind and segment wall uniformly thin, color of pulp comparatively deep, central column medium-sized, with medium or rather little amount of pith. The pulp soft and juicy, good quality. The rind has uniform thickness and oil cells are apart and very much rounded in shape. Segments are separate at the centre and rather easily separable from the rind. At the time of the first pick, the segment wall was rather thick and the pith was rather abundant. In comparison with the individual "Gold Medal" studied before, the fruit looked slightly smaller and the mixture of taller off-type fruits were more numerous. General characters, however, were quite similar, being equally very excellent as commercial products.

These trees were since then valued highly by progressive Citrus growers, and were very extensively propagated through the generous consent of the owner. As the result of too much removal of budwoods, both trees were in a stunted condition in 1925 and seemed to require a period of rest, especially in the latter individual. It is concluded, however, that the existence of individuality beneficial to the grower, within the variety of Hira Satsuma, is definitely established, as is proved by the discovery of these two excellent individuals. It is also warranted that

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\* PL. X, Fig. 1 & 2.

TABLE 48.

MEASUREMENT OF FRUITS OF "EXCELSIOR" INDIVIDUAL OF HIRA VARIETY  
OF SATSUMA ORANGE FROM YAKUSHIJI'S ORCHARD AT TACHIMA.  
LOT NO. 49-50. 356 FRUITS (NOS. 332-441, 3121-3366).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.56 cm.	4.19 cm.	1.48	82.43 gm.	10.97 mm.	10.97	2.47 mm.	14.10 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	356	—	—	—	—	—	134	37.64%
Sinuate based fruits	356	—	—	—	—	—	3	0.84
Semi-sinuate based fruits	356	—	—	—	—	—	27	7.58
Areolated fruits	356	—	—	—	—	—	168	47.19
Frs. with undeveloped calyx lobes	351	—	—	—	—	—	33	9.40
Frs. with long narrow calyx lobes	351	—	—	—	—	—	8	2.28
Fruits containing seeds	256	—	—	—	—	—	8	2.25
Apical depression	356	46 12.92	111 31.18	162 45.51	37 10.39%	—	—	—
Apical dots	356	0 0	31 8.71	325 91.27%	—	—	—	—
Flatness of fruit	356	255 71.63	89 25.00	11 3.09	1 0.28	0 0%	—	—
Smoothness of fruit	356	50 14.04	170 47.75	103 28.93	33 9.27%	—	—	—
Thinness of rind	356	283 79.49	70 19.66	2 0.56	1 0.28	0 0%	—	—
Thinness of segment wall	355	253 71.27	94 26.48	5 1.41	3 0.15	0 0%	—	—
Color of pulp	355	333 65.63	116 32.68	6 1.69	0 0	0 0%	—	—
Size of central column	356	3 0.84	51 14.33	251 70.51	48 13.45	3 0.84%	—	—
Quantity of pith	356	2 0.56	45 12.64	284 79.78	25 7.02	0 0%	—	—
Quality of pulp	351	152 43.30	117 33.33	73 20.80	9 2.56	0 0%	—	—

such investigation for the selecting of superior individuals is useful and helpful to the progress of the Citrus industry.

*Comparison of the Hira and the Owari varieties*

In the search through Mr. YAKUSHIJI's orchard, a tree was found having an apparent similarity to the Hira variety but it really was Owari, having been introduced from Ôsaka Prefecture and planted by Naosaburô YAKUSHIJI. This plant was bearing flat fruits, and was thought very adequate material for the study on the difference between Owari and Hira, as an individual closely approaching Hira. The individual, provisionally named "Perfect", is located in the Nishinotani orchard, and is described as follows:

Lot No. 51 of 1920. Individual "Perfect" of YAKUSHIJI's Owari Satsuma. Standing above a hut, right hand side beyond the road, the first tree, having a distance of 2.9 m. from the northern tree, and 3.3 m. from the N-W tree. It is 17 years after planting, with an F-W spread of 2.3 m., N-S spread of 2.6 m., and a height of 2 m. It has a single trunk bearing heavy branches, rather erect and not spreading, the number of branches are few. Leaves long, narrow, not dense, more or less boat shaped, not undulate, more recurved, and straight. Apex sharp pointed, base also narrow, petiole acute-angled to the shoot. Moderately bearing. Soil clayey loam containing pebbles, rich in organic matter, weeds left uncut, no mulch. Fruit ripens in the early part of November and was never used for exhibition. About 200 nursery plants were bought at the same time, and only two individuals are bearing such flat, smooth fruit. The measurements of fruits are given in Table 49.\*

The fruit is medium in size, depressed obconical, moderately flattened, comparatively flat but not so flat as Hira, smooth and slightly pitted, rather flattened at the apex but more or less conspicuously depressed at the base, calyx very large. Navel generally not much developed, areola moderately developed. Fruits were in perfect condition when picked,

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\* PL. X, Fig. 3.

TABLE. 49.  
MEASUREMENT OF SATSUMA FRUITS OF YAKUSHIJÛ'S FLAT OWARI, IN-  
DIVIDUAL "PERFECT" AT TACHIMA. LOT NO. 51. TOTAL NUMBER  
OF FRUITS, 229 (NOS. 539-767), ENTIRE CROP.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.61 cm.	4.40 cm.	1.42	89.01 gm.	11.16 mm.	10.78	2.28 mm.	12.15 mm.

No. of fruits examined		Calss					Total	
		1	2	3	4	5		
Naveled fruits	229	—	—	—	—	—	57	% 24.88
Sinuate based fruits	229	—	—	—	—	—	0	0
Semi-sinuate based fruits	229	—	—	—	—	—	48	20.96
Areolated fruits	229	—	—	—	—	—	91	29.74
Frs. with undeveloped calyx lobes	227	—	—	—	—	—	35	15.42
Frs. with long narrow calyx lobes	227	—	—	—	—	—	2	0.88
Fruits containing seeds	229	—	—	—	—	—	4	1.75
Apical depression	229	0 0	6 2.62	128 55.90	95 41.48%	—	—	—
Apical dots	229	2 0.87	57 24.89	170 74.24%	—	—	—	—
Flatness of fruit	229	148 64.63	78 34.06	3 1.31	0 0	0 0%	—	—
Smoothness of fruit	229	73 31.88	133 58.08	18 7.86	5 2.18	0 0%	—	—
Thinness of rind	227	125 55.07	73 32.16	24 10.59	5 2.20	0 0%	—	—
Thinness of segment wall	227	100 44.05	103 45.37	14 6.17	6 2.64	4 1.76%	—	—
Color of pulp	227	59 25.99	103 45.37	52 22.91	10 4.41	3 1.32%	—	—
Size of central column	227	3 1.32	20 8.81	152 66.96	41 18.06	11 4.85%	—	—
Quantity of pith	227	9 3.96	94 41.41	124 54.63	0 0	0 0%	—	—
Quality of pulp	225	21 9.22	63 28.00	107 47.56	22 9.78	12 5.33%	—	—

without blemishes or sour scab. In halved fruit, the rind is medium-thin, segment wall also medium-thin, size of central column rather uniformly medium-thin or medium, and there is rather much pith. Quality of pulp is not of any merit, although softness and juiciness are very pronounced.

Although the individual approaches the true Hira in its general aspects, the detailed characters, such as the shape of fruit, size of calyx, lower grade of pulp, etc., are sufficient to distinguish it from the former, but it can be imagined that the origin of the Hira variety may be traced back to such an individual of the Owari, through unconscious propagation at an early period. At present, the Hira variety is a well isolated type of Satsuma orange, having a remarkable character of fruit, habit of growth, and different shape of leaves.

### DISTRIBUTION OF OWARI AND ZAIRAI VARIETIES

As is stated before, the merit of the Owari variety was first recognized with the increase of activity of the Idzumi nurseries in Ōsaka Prefecture. Being encouraged by large orders from this district, the nurserymen of Owari Province, especially those of Chiyoda and Meiji, villages of Nakajima county, started a large scale propagation of the Owari variety in an enormous quantity. As a natural result of the expansion of the business, these Owari nurserymen soon became independent from the Idzumi nurseries, and began to carry on their trade directly with the Citrus growers. These plants from Owari were named "Kairyō Unshū" (Improved Satsumas) or were generally called "Owari-nae" (Owari nursery stock), and have been famous since about 1895. Because of the geographical advantage, Shidzuoka and Kanagawa Prefectures have almost exclusively received Owari nursery plants from the beginning of their present activity, while western prefectures have mostly obtained their Owari plants from Idzumi nurseries. Through the author's investigation, however, it became clear that the Owari variety was not originated in Owari Province, but that it had existed for a long period in Kyushu Island, especially in Nagasaki Prefecture. It was also proved that there still exist a number

of superior individuals of the same variety not known in other places. It is then a well founded assumption that the variety must have been brought to other places, at least in a small quantity, before the activity commenced in the nurseries of Owari and Idzumi Provinces. So far as there is no clue for the direct introduction of the variety from Kyushu to Owari Province, it is natural to think that the variety has traveled the way step by step before reaching its destination. If this be true, Owari trees should exist in various places lying between the western end of Kyushu and Aichi Prefecture, and probably, still more eastern provinces where the Satsuma has been known for a long period. It is an interesting problem to trace these early distributed Owari plants in the Satsuma growing districts of eastern Kyushu Island, Shikoku Island, and Honshû (the main island). The Zairai variety also may have been brought into these districts, because varietal differences were not a serious problem in the early period. To bring this problem to a satisfactory solution, attention must be concentrated in investigating the existing old trees of Satsuma orange and to determine their proper place. The following is the result of a survey conducted by the author to solve this question. This most extensive study of old Satsuma trees brought a remarkable record of the early distribution of Owari and Zairai varieties, and gave a scientific basis to the assumption of the gradual movement of the former variety to the eastern Citrus districts.

#### *Distribution of Owari variety in Kyushu Island*

In the first place, the early distribution of Owari variety in Kyushu Island was sought. The existence of this variety in Shikoku Island has already been discussed in the previous chapter.

In Kagoshima and Fukuoka Prefectures, it was not possible to locate any existing old Owari Satsuma tree, and it is reasonable to think that it was not brought into these prefectures in early times.

As a proof of this statement, an account of the old Satsuma tree in Kagoshima Prefecture is given in another chapter. This is known under the name "Tômikan", and represents the Zairai variety.

Lot No. 17 of 1919. Single tree in Kōkwaen orchard, owned by Toranoshin SHIGENOBU, at Yoshino-mura, near Kagoshima city. Unpruned tree of about 20 years of age, planted in 1901, standing on a flat place below a hill, at the left of a road leading from house to manure hut, planted 3.5 m. away from next trees, with spread of 4 m. on both E-W and N-S directions and height of 2.6 m. Branches rather complicated but not drooping, spreading in every direction in good order. Leaves rather broad, more or less hanging, tapering at the base. Soil and treatment as Lot No. 18 already stated. The plant is the sole existing "Tōmikan", having been preserved from the time the Experiment Station was located there. The measurements of fruits are given in Table 50.\*

The study shows that this is unquestionably the Zairai variety, the fruit having an oblate, not a conical outline, small calyx, sinuate base, rounded apex and poor quality of pulp. The rind was moderately thin, segment wall also rather thin, central column ranging from large to small, and pith grading from much to little. In comparing these figures with those of Tables 26 (Owari in Kagoshima, later introduction) and 25 (Ikiriki-Owari in Kagoshima), it can be seen that Owari fruits have a more flat outline, very small amount of sinuate based fruit, a much smoother surface, thinner rind and segment wall, little amount of pith, and better quality of pulp. Moreover, the Owari fruits were more conical than the Zairai here given. These plants were grown in the same place and were studied almost at the same time, still the difference was very great, as is shown by this statistical study.

In Kimotsuki county of Kagoshima Prefecture there are several large plantings of the Owari variety of recent introduction, which are gaining a good reputation on account of the superiority of their fruits over that of plants of an earlier introduction. A detailed account of them is given in a later chapter.

In Fukuoka Prefecture, where the Owari variety was unknown, a plantation of "Kairyō Unshū" from Owari Province in the orchard of

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\* PL. XI, Fig. 1. .

TABLE 50.

MEASUREMENT OF SATSUMA FRUITS OF LOCAL TYPE (ZAIRAI) OF KAGOSHIMA,  
AT KÔKWAEN ORCHARD, NEAR KAGOSHIMA CITY. LOT NO. 17  
OF 1919. TOTAL NUMBER OF FRUITS, 278.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.18 cm.	4.20 cm.	1.39	74.26 gm.	—	10.89	2.42 mm.	12.01 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	278	—	—	—	—	—	126	45.32%
Sinuate based fruits	274	—	—	—	—	—	206	75.14
Semi-sinuate based fruits	274	—	—	—	—	—	1	0.37
Areolated fruits	278	—	—	—	—	—	38	13.67
Frs. with undeveloped calyx lobes	35	—	—	—	—	—	9	25.71
Frs. with long narrow calyx lobes	35	—	—	—	—	—	0	0
Fruits containing seeds	278	—	—	—	—	—	129	46.40
Apical depression	276	32 11.59	71 25.72	100 36.23	73 26.45%	—	—	—
Apical dots	276	8 2.90	104 37.68	164 59.42%	—	—	—	—
Flatness of fruit	278	26 9.35	173 62.23	68 24.46	11 3.96	0 0%	—	—
Smoothness of fruit	276	6 2.17	69 25.00	141 51.09	33 11.96	27 9.78%	—	—
Thinness of rind	278	129 46.40	84 30.22	45 16.19	17 6.12	3 1.08%	—	—
Thinness of segment wall	277	165 59.57	65 23.47	16 5.78	26 9.39	5 1.81%	—	—
Color of pulp	276	139 50.36	111 40.22	18 6.52	0 0	8 2.90%	—	—
Size of central column	277	5 1.81	19 6.86	207 74.73	38 13.72	8 2.89%	—	—
Quantity of pith	276	27 9.78	100 36.23	131 47.46	15 5.43	3 1.09%	—	—
Quality of pulp	268	32 11.94	86 32.09	92 34.33	54 20.15	4 1.49%	—	—



Shiroshi HARA at Yoshii, won a fine reputation. The following is the record of an individual, taken in 1919 by the individuality method.

Lot No. 11 of 1919. New introduction Owari Satsuma at the Teshiroyama orchard of Shiroshi HARA, on the slope of Minô mountain, above a terrace built with a stone wall, called No. 1 plot (west end), standing on the 4th terrace, being the tree at the north-eastern corner. Age about 23 years after planting, with E-W spread 2.3 m., N-S spread 2 m., height 2 m., being a good shaped tree with dense foliage, appearing a typical Owari tree. The plants were introduced from Owari Province by Yoshinori HARA, the previous owner of the orchard. The measurements of fruits are given in Table 51.\*

By mistake, fruits were picked very late in the season, so that an unexpected puffing of the skin resulted, causing an increase of roughness and thickness of the rind, fading of the color and insipidness of the pulp. Similarly, the size of the central column, thinness of the segment wall, and the quantity of the pith were slightly affected.

The outline of fruits was flat, but a crater-like shoulder near the base gave a little larger stature to the fruit.

The comparison of the figure to that of the Zairai grown in the same place (Table 31, Lot. No. 22), gives a great contrast. The Zairai fruits have a sinuate base and very undeveloped calyx lobes. Their apex is not so much depressed, the outline is much taller, and surface more rough. Their rind is almost as thick but the segment is very much thicker and the pith is more abundant. Although these Zairai fruits were picked in the right season and had a normal color of pulp, the quality of the latter was very inferior. The result is enough to show the difference of both varieties. The commercial difference is also well shown by the fact that the Owari fruit of this orchard is sold at 9 yen per 100 kin (15 yen per 100 kg.), while the Zairai fruit of the same locality is marketed at a price between 6 and 8 yen (10.00-13.33 yen per 100 kg.) Mr. Uichirô SAEKI, County Agent, informed us that these Owari trees were hardier and a little earlier in ripening than the local Zairai trees.

In the prefectures of Kumamoto and Saga, where the Owari variety

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\* PL. XI, Fig. 2.

TABLE 51.

MEASUREMENT OF OWARI SATSUMA FRUITS FROM HARA'S ORCHARD AT  
YOSHII, FUKUOKA-KEN. LOT NO. 11 OF 1919. TOTAL NUMBER  
OF FRUITS, 474.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.56 cm.	4.30 cm.	1.37	66.34 gm.	—	10.24	2.78 mm.	10.73 mm.

No. of fruits examined		Calss					Total	
		1	2	3	4	5		
Naveled fruits	474	—	—	—	—	—	55	% 11.60
Sinuate based fruits	473	—	—	—	—	—	25	5.29
Semi-sinuate based fruits	473	—	—	—	—	—	97	20.51
Areolated fruits	474	—	—	—	—	—	76	16.02
Frs. with undeveloped calyx lobes	348	—	—	—	—	—	77	22.13
Frs. with long narrow calyx lobes	348	—	—	—	—	—	15	4.31
Fruits containing seeds	474	—	—	—	—	—	74	15.61
Apical depression	474	298 61.81	130 27.43	44 9.28	7 1.48%	—	—	—
Apical dots	473	59 12.47	163 34.46	251 53.07%	—	—	—	—
Flatness of fruit	474	88 18.57	314 66.24	70 14.77	1 0.21	1 0.21%	—	—
Smoothness of fruit	474	7 1.50	261 55.66	47 9.92	159 33.54%	—	—	—
Thinness of rind	474	75 15.82	117 24.68	164 34.60	76 16.03	35 7.97%	—	—
Thinness of segment wall	474	386 81.43	73 15.40	4 0.84	8 1.69	3 0.63%	—	—
Color of pulp	472	71 15.04	288 61.02	112 23.73	0 0	1 0.21%	—	—
Size of central column	474	1 0.21	16 3.38	340 71.73	105 22.15	12 2.53%	—	—
Quantity of pith	474	4 0.84	16 3.38	381 80.38	68 14.35	5 1.05%	—	—
Quality of pulp	464	14 3.02	129 27.80	278 59.91	42 9.05	1 0.22%	—	—

was expected without a doubt, no particular work was conducted. This is chiefly for the reason that no profitable individuality experiment was expected because of the lack of intelligent assistants and the inconvenient location of the producing centers. Saga is unquestionably under the influence of the Ikiriki districts of Nagasaki, and the condition is assumed to be exactly similar. Kumamoto, on the other hand, has developed its own Satsuma industry, but compared with the activity of the Kinokuni industry, its development is rather subsidiary, and this condition is entirely different from that of Nagasaki and Fukuoka, where the Satsuma holds unparalleled importance.

In Kumamoto Prefecture it is difficult to trace back the earliest period when the Satsuma was first planted, but according to ABE<sup>(2)</sup>, the oldest planting in Kawachi village dates back to 1782. In visiting the producing centres of Kawachi and Oama, it was found impossible to locate adequate material enough to give sufficient proof concerning its origin. It was, however, noticed that the plants propagated locally were most likely the Owari variety, and in most of the local representative orchards, no Zairai plants were found. These orchards were all comparatively young, and no study was carried on that account.

#### *Very old Zairai plant in eastern Kyushu*

In the Tsukumi and the Aoë region in Ôita Prefecture, eastern Kyushu, investigations were carried on very actively in connection with the Wase variety, and there was an ample chance to study the local varieties of the Satsuma orange. There was found a huge old Satsuma tree still in existence, as is shown in an other place in this report, and the plant furnished very good material for the study of varieties. The description of this tree is given below :

Lot No. 40 of 1920. Satsuma tree of enormous size, in the orchard of Toyoji KAWANO, Kuratomi, Aoë-mura, Ôita Prefecture (Pl. XLVIII, Fig. 3.). Standing in the Kusugaseko Kinokuni orchard, on a moderate slope inclined toward the west, a solitary tree looking almost 200 years of age but may be slightly younger, located at the east of a narrow path,

about 17.4 m. away from the eastern tree. It has an E-W spread of 10.5 m., N-S spread 12.2 m., and height 7.4 m.; the girth of the bottom measures 1.9 m. and it is divided into three main trunks having girths of 96 cm., 93 cm., and 72 cm., respectively. The trunk and branches are rather upright in habit, but the branchlets are rather numerous and very much crowded, running in every direction and hanging at the tips. Leaves are large, undulate, deep-colored, with recurved margin. Fruits on tree are large and oblate, few in number, and scabby. Soil appeared fertile, being rich in organic matter. The crop of the whole tree was studied in 1920, the measurements of which are given in Table 52.\*

The fruits range from very large to small, with a large number of culls. Shape is medium-flat to medium with high shoulder so as to give a regular depressed globose outline. Texture is compact, elastic, and surface is rather even, not strongly pitted, oil cell dots being both convex and concave, but very indistinct. Base of fruits sinuous in many cases, a few of them being shallowly concave without conspicuous grooves. Calyx is small, lobes not well developed, light-colored and thick. Apex of fruits is also shallowly concave, areola is common but the navel is less frequent. These fruits were in full maturity but were scabby, hence occasionally green spotted. Bruise was frequent as the fruits were mostly beaten down because of being out of reach. In the cross-section, the rind is thin and the segment wall is thick, the outer corner being rounded. The oil cells are round and apart. The central column is medium-sized with abundant pith, which is rather hardened at the inner blunt end of segment wall. Pulp is rather deep-colored, vesicles coarse-grained, netting mostly stretched, rather hard-walled and not melting, juice being scanty. In large fruits, the taste was generally good, but on the average, it was very variable and inferior. Some percent of the fruits were off-type late-bloom fruits and were not normal. From these characters the tree is judged to be Zairai. Owari fruits must have a somewhat conical outline, larger depression at both ends, larger calyx, thinner segment wall, more reticulate pulp vesicles, and larger central column.

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\* PL. XI, Fig. 3.

TABLE 52.

MEASUREMENT OF SATSUMA FRUITS OF HUGE OLD ZAIRAI TREE IN  
KAWANO'S ORCHARD AT AOE, ÔITA-KEN. LOT NO. 40 OF 1920.  
TOTAL NUMBER OF FRUITS, 497 (NOS. 5663-6159).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.53 cm.	4.19 cm.	1.41	79.12 gm.	9.57 mm.	10.20	2.68 mm.	13.10 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	497	—	—	—	—	—	82	16.50%
Sinuate based fruits	495	—	—	—	—	—	311	62.83
Semi-sinuate based fruits	495	—	—	—	—	—	24	4.85
Areolated fruits	497	—	—	—	—	—	264	53.12
Frs. with undeveloped calyx lobes	233	—	—	—	—	—	91	39.06
Frs. with long narrow calyx lobes	233	—	—	—	—	—	5	2.15
Fruits containing seeds	497	—	—	—	—	—	52	10.46
Apical depression	497	3 0.60	56 11.27	385 77.46	53 10.66%	—	—	—
Apical dots	495	21 4.24	148 29.90	326 65.86%	—	—	—	—
Flatness of fruit	497	32 6.44	224 45.07	212 42.66	27 5.43	2 0.40%	—	—
Smoothness of fruit	497	13 2.62	191 38.43	273 54.93	9 1.81	11 2.21%	—	—
Thinness of rind	496	236 47.58	126 25.40	106 21.37	19 3.83	9 1.81%	—	—
Thinness of segment wall	495	30 6.06	176 35.55	209 42.22	60 12.12	20 4.04%	—	—
Color of pulp	496	237 47.78	192 38.71	64 12.90	2 0.40	1 0.20%	—	—
Size of central column	496	4 0.81	28 5.65	361 72.78	75 15.12	28 5.65%	—	—
Quantity of pith	496	125 25.20	234 47.18	134 27.62	0 0	0 0%	—	—
Quality of pulp	386	26 6.74	73 18.91	215 55.70	54 13.99	18 4.66%	—	—

*Owari from eastern Kyushu*

On the other hand, local Owari plants were also in existence in the Tsukumi and Azamui sections in Ôita Prefecture, eastern Kyushu. Some Tsukumi plants were used for comparison with the local Owari of Ôchô village of the Inland sea district in 1919.

As is fully discussed later, bud sticks of Kawano Wase Satsuma were introduced into Ôchô village in 1903 from Aoe and Tsukumi. One of the Aoe plants was two-budded and dual in nature, being partly not Wase. Buds from this part were also brought in, resulting in a mixture of progeny when propagated in Ôchô. These non-Wase Satsuma brought from eastern Kyushu were called in Ôchô "Tsukumi local", and about 30 per cent of the plants propagated from the original bud sticks taken from that region were such. The source of these buds was found by the author to be the No. 3 plant of Kawano Wase in its original orchard, which has one limb top-worked with Wase, but was not Wase when the buds were removed for the Ôchô growers. The practice of propagation in the Tsukumi region is to plant out the trifoliate stock first and as it grows large, two or three scions are grafted on to it, and that particular plant had accidentally received two different kinds of scions. This will explain how the origin of the "Tsukumi local" came from a single limb, probably a common type of the Satsuma grown there. There is, however, another type of common Satsuma having a peculiar origin, that is, the Satsuma originated through vegetative reversion from Kawano Wase trees. Although details of this account will be given later, it is now evident that two kinds of Satsuma (not Wase) exist in Ôchô in connection with the introduction from eastern Kyushu, both being called "Tsukumi local". They involve two types of Satsuma, which are roughly classified by Mr. Gosaku SUEOKA, former executive officer of the village, as "Small Tsukumi local" and "Large Tsukumi local". It is, therefore, an extremely interesting problem to find out to which variety they do belong. By his generous offer, two representative plants were picked out from his orchard trees, and they were used for study. The description of these trees is as follows:

Lot No. 14 of 1919. "Small Tsukumi local" individual in Ippôtôge plot of Mr. SUEOKA's orchard. Standing on a single row terrace of a very steep hill, in the 9th row from the bottom, the second tree from the west, planted 4.35 m. away from other trees. Unpruned tree 12 years after planting, with E-W spread 2 m., N-S spread 1.6 m., and height 1.4 m. Upright habit, with thick upright shoots, western limb being half defoliated with loose foliage. Leaves large and broad, upright or hanging. Soil sandy loam of sandstone origin; surface soil deep but not rich. Fertilizer constitutes of a mixture of ten different kinds of preparations; no mulch. This is a third generation tree from the original individual propagated from Aoe (or Tsukumi) bud sticks. Fruits color in the middle of December, quality is said to be a little inferior to the "Ôchô local" later described. The measurements of fruits are given in Table 53.\*

Lot No. 16 of 1919. "Large Tsukumi local" individual in Mr. SUEOKA's orchard. Location same as above, but on the 8th terrace from the bottom, second tree from west. Unpruned tree 12 years after planting, with E-W spread 2.6 m., N-S spread 1.9 m., and height 1.7 m. Habit utmost upright, having compact branching with dense foliage. Leaves large, upright or more or less hanging, broad. The measurements of fruits are given in Table 54.\*\*

Fruits of these lots are almost similar in general appearance, except for size. The tallness of the latter lot is due to a mixture of unusual pear-shaped fruits. In both lots, the calyx was large, but the percentage of fruits with undeveloped calyx lobes and those of sinuate bases are conspicuously large, and they are not typical Owari in these respects. Both have a deep apical depression and a deep, grooved sinuation at the base, which are rather safe Owari characters. Compare with Lot No. 5 of 1919, Owari from Wase reversion.

#### *Owari existed long in Ôchô*

Like eastern Kyushu, Ôchô village of the Inland Sea district, has its own Owari from an early period, called "Ôchô local". One such,

\* PL. XII, Fig. 1.

\*\* PL. XII, Fig. 2.

TABLE 53.

MEASUREMENT OF SATSUMA FRUITS OF SMALL TSUKUMI LOCAL, IN SUEOKA'S ORCHARD, AT ÔCHÔ. LOT NO. 14 OF 1919. TOTAL NUMBER OF FRUITS, 164.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.07 cm.	4.35 cm.	1.40	75.36 gm.	—	10.05	3.16 mm.	12.61 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	164	—	—	—	—	—	0	% 0
Sinuate based fruits	159	—	—	—	—	—	18	11.32
Semi-sinuate based fruits	159	—	—	—	—	—	0	0
Areolated fruits	164	—	—	—	—	—	73	44.51
Frs. with undeveloped calyx lobes	135	—	—	—	—	—	46	34.07
Frs. with long narrow calyx lobes	135	—	—	—	—	—	8	5.93
Fruits containing seeds	164	—	—	—	—	—	0	0
Apical depression	164	84 52.22	53 32.32	20 12.19	7 4.26%	—	—	—
Apical dots	164	15 9.15	75 45.73	74 45.12%	—	—	—	—
Flatness of fruit	164	15 9.16	146 89.02	3 1.83	0 0	0 0%	—	—
Smoothness of fruit	164	0 0	16 9.76	102 62.20	46 28.04%	—	—	—
Thinness of rind	164	1 0.61	10 6.10	90 54.88	46 28.05	17 10.37%	—	—
Thinness of segment wall	163	114 69.94	34 20.86	11 6.75	4 2.45	0 0%	—	—
Color of pulp	164	1 0.61	40 24.39	121 73.78	0 0	2 1.22%	—	—
Size of central column	164	0 0	29 17.68	130 79.27	4 2.44	1 0.61%	—	—
Quantity of pith	163	0 0	38 23.31	119 73.01	6 4.68	0 0%	—	—
Quality of pulp	161	6 3.73	44 27.33	103 63.98	8 4.97	0 0%	—	—



TABLE 54.

MEASUREMENT OF SATSUMA FRUITS OF LARGE TSUKUMI LOCAL, IN SUEOKA'S ORCHARD, AT ÔCHÔ. LOT NO. 16 OF 1919. TOTAL OF FRUITS, 141.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.57 cm.	4.72 cm.	1.29	91.93 gm.	—	10.80	3.08 mm.	14.84 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	141	—	—	—	—	—	7	% 4.96
Sinuate based fruits	141	—	—	—	—	—	84	59.57
Semi-sinuate based fruits	141	—	—	—	—	—	54	38.30
Areolated fruits	141	—	—	—	—	—	67	47.52
Frs. with undeveloped calyx lobes	31	—	—	—	—	—	2	6.45
Frs. with long narrow calyx lobes	31	—	—	—	—	—	0	0
Fruits containing seeds	141	—	—	—	—	—	0	0
Apical depression	140	127 90.71	10 7.14	0 0	3 2.14%	—	—	—
Apical dots	140	50 35.71	64 45.71	26 18.57%	—	—	—	—
Flatness of fruit	141	17 12.06	116 82.27	7 4.97	1 0.71	0 0%	—	—
Smoothness of fruit	141	0 0	9 6.38	83 58.87	49 34.76%		—	—
Thinness of rind	141	16 11.35	33 23.40	60 42.55	12 8.51	20 14.18%	—	—
Thinness of segment wall	141	74 52.48	48 34.04	12 8.51	5 3.55	2 1.42%	—	—
Color of pulp	141	24 17.02	90 63.83	27 19.15	0 0	0 0%	—	—
Size of central column	140	12 8.57	43 30.71	76 54.29	8 5.71	1 0.71	—	—
Quantity of pith	140	0 0	6 4.29	116 82.86	18 12.86	0 0%	—	—
Quality of pulp	138	44 31.88	66 49.83	28 20.29	0 0	0 0%	—	—

located in Mr. SUEOKA's orchard, was used for the purpose of comparison with these "Tsukumi local" plants. It is described below :

Lot No. 13 & 14 of 1919. "Ochô local" individual in Bessô plot of Mr. SUEOKA's orchard. Standing on a slope, 5th terrace from the top, east of a road, first tree from the west, planted 4 m. away from neighbouring trees, being a lightly pruned tree 16 years from first setting, with E-W spread 3 m., N-S spread 2.5 m., and height 2 m. Habit moderately spreading, head rounded, branches thick. Leaves large, dense, hanging, pointed, deep-colored. The origin is unknown, but this type of tree has been in existence for many years. Exclusive of the Wase plants, about 80 per cent of the rest is this type, and the remaining 20 percent consists of Satsumas which came from the provinces of Owari, Idzumi, and Kii. Fruits are picked from the middle of December. The measurements of fruits are given in Table 55.\*

This lot is very similar to the two given above, and especially resembles the latter in size. The shape of fruit is conical, having a large apical depression and large calyx. A comparatively large amount of sinuate based fruits is characterized as a type having a deep sinuation, which may later change into a deep, grooved base. This is rather frequent in Owari fruit, appearing at an early stage as a crater-like stem-end. All other features, such as thickness of the rind, thinness of the segment wall, moderately deep-colored pulp, rather large central column with a less than medium amount of pith, fair quality of pulp, etc., are all identical with the former lot.

#### *Owari resulting from vegetative reversion*

For the purpose of reference, a plant resulting from vegetative reversion from a Kawano Wase is described below. The lot consists of a small tree at the Nagasaki Experiment Station at Nakagawa, Nagasaki city, introduced as a tree representing the Kawano Wase but which turned out to be Reversion Owari. Brief description follows :

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\* PL. XII, Fig. 3, & PL. XIII, Fig. 1.

TABLE 55.

MEASUREMENT OF SATSUMA FRUITS OF SUBOKA'S ÔCHÔ LOCAL (OWARI)  
 VARIETY, AT ÔCHÔ. LOT NO. 13 & 15 OF 1919. TOTAL  
 NUMBER OF FRUITS, 147.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.05 cm.	4.91 cm.	1.37	108.36 gm.	—	10.15	3.19 mm.	15.24 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	147	—	—	—	—	—	0	% 0
Sinuate based fruits	146	—	—	—	—	—	56	38.36
Semi-sinuate based fruits	146	—	—	—	—	—	63	43.15
Areolated fruits	147	—	—	—	—	—	43	29.25
Frs. with undeveloped calyx lobes	98	—	—	—	—	—	21	21.43
Frs. with long narrow calyx lobes	98	—	—	—	—	—	3	3.06
Fruits containing seeds	147	—	—	—	—	—	2	1.36
Apical depression	147	84 57.14	48 32.65	11 7.48	4 2.72%	—	—	—
Apical dots	147	23 15.65	52 35.37	72 48.98%	—	—	—	—
Flatness of fruit	147	8 5.44	125 85.03	13 8.84	1 0.68	0 0%	—	—
Smoothness of fruit	147	3 2.04	33 22.45	80 54.42	29 19.73	2 1.36%	—	—
Thinness of rind	145	30 20.69	69 47.59	32 22.07	11 7.59	3 2.07%	—	—
Thinness of segment wall	145	62 42.76	68 46.90	10 6.89	5 3.45	0 0%	—	—
Color of pulp	144	46 31.94	77 53.47	21 14.58	0 0	0 0%	—	—
Size of central column	142	4 2.82	49 34.51	39 62.68	0 0	0 0%	—	—
Quantity of pith	140	0 0	8 5.71	119 85.00	13 9.29	0 0%	—	—
Quality of pulp	138	28 18.84	55 39.86	55 39.86	1 0.72	1 0.72	—	—

Lot No. 5 of 1919. Owari Satsuma (labeled Wase) at the Nakagawa orchard of the Nagasaki Agricultural Experiment Station. Planted 2.6 m. away from others in plot No. 19, on a moderate slope, the 5th tree from the east on the lower-most row. Unpruned tree having an E-W spread of 1.7 m., N-S spread of 1.7 m., and height of 1.7 m. Branches few, thick, strong, dispersed and drooping, due to a considerable elongation. Leaves large, broad, attached with long internodes, deep-colored, both apex and base obtuse. The measurements of fruits are given in Table 56.\*

This table shows that the fruit has the typical deep concave apex and quite conical outline but the basal depression is not yet developed. The surface is rather rough, strongly areolate, and much naveled. Thickened rind, thin segment wall, pulp melting and of fair quality, are all characteristic of this type of Owari fruit.

The existence of the Owari variety in the Tsukumi and the Aoe regions for a long period is no longer doubtful, and the fact that the Owari variety resulted through the vegetative reversion of the Kawano Wase gives sufficient proof that the original Wase mutation happened in the Owari variety, as suggested before by the author<sup>(170)</sup>. This will be discussed still more fully in later parts of this report.

#### *Non-existence of Zairai in western Shikoku*

The fact that the Tsukumi and the Aoe regions have had both Owari and Zairai varieties from an early time suggests that a similar condition may exist on the opposite coast of Shikoku Island. A thorough survey in the Tachima region, however, gave no positive proof for this assumption. A very old Satsuma tree located not far from the aged Owari Satsuma tree already described (Table 45), was first suspected to be something like Zairai, but the individuality study plainly disproved it. The description of this plant is below:

Lot No. 39 of 1920. Old Owari Satsuma in Tachima village, at the Yashiki orchard of Tokutarô YAKUSHIJI (PL. XLVIII, Fig. 4.). A

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\* PL. XIII, Fig. 2.

TABLE 56.

MEASUREMENT OF SATSUMA FRUITS FROM A TREE OF NAGASAKI EXP. STAT.,  
 REPRESENTING REVERSION OWARI LABELED WASE. LOT NO. 5  
 OF 1919. TOTAL NUMBER OF FRUITS, 101.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.98 cm.	4.32 cm.	1.32	72.47 gm.	—	11.00	2.45 mm.	11.08 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	101	—	—	—	—	—	39	% 38.61
Sinuate based fruits	101	—	—	—	—	—	92	91.09
Semi-sinuate based fruits	101	—	—	—	—	—	1	0.99
Areolated fruits	101	—	—	—	—	—	47	46.53
Frs. with undeveloped calyx lobes		(not observed)						
Frs. with long narrow calyx lobes		(not observed)						
Fruits containing seeds	101	—	—	—	—	—	64	63.37
Apical depression	100	63 63.00	12 12.00	16 16.00%	—	—	—	—
Apical dots	101	13 12.87	47 46.53	41 40.59%	—	—	—	—
Flatness of fruit	101	4 3.96	32 31.68	58 57.43	7 6.93	0 0%	—	—
Smoothness of fruit	100	0 0	14 14.00	42 42.00	34 34.00%	—	—	—
Thinness of rind	100	15 15.00	26 26.00	39 39.00	13 13.00	7 7.00%	—	—
Thinness of segment wall	100	52 52.00	29 29.00	11 11.00	8 8.00	0 0%	—	—
Color of pulp	100	68 68.00	26 26.00	0 0	0 0	6 6.00%	—	—
Size of central column	100	0 0	1 1.00	71 71.00	18 18.00	10 10.00%	—	—
Quantity of pith	100	0 0	43 43.00	41 41.00	15 15.00	1 1.00%	—	—
Quality of pulp	98	2 2.04	20 20.41	52 53.41	20 20.41	4 4.08%	—	—

single tree about 85 years old, standing on a moderate slope above the house, having an E-W spread of 7.8 m., N-S spread of 9.8 m., and height of 5.6 m. Shape of tree hemispherical, trunk thick, with girth of 1.55 m., which trunk soon divides into 5 major branches with girths of 88 cm., 71 cm., 52 cm., 38 cm., and 59 cm., respectively. Branches very much zigzag, leaves partly defoliated by greasy spot disease, sound leaves large, deep green, wavy, and hanging. Soil is loam, rich in organic matter. Almost no fertilization. It is said that the Satsuma was in existence in the grounds of Tokuzô AKAMATSU, at least 85 years ago, that it came from an unknown place, probably the opposite coast in Kyushû Island, but the villagers did not propagate such trees until a pilgrim from Kishû taught them how to practice grafting. The first generation trees thus multiplied are no longer in existence, but there are several second generation trees about 80 years old still living in the vicinity. One of these trees here described was completely picked for study, and the measurements of fruits are given in Table 57.\*

The fruit of this lot is large, ranging widely from large to small, including many culls. Shape is medium-flat, oblate, slightly conical, apex rather concave, with fairly well developed areola and navel. Base more or less sinuous, or broadly concave, disk considerably large-sized. Surface rough, oily, much pitted, very deep-colored, and often more or less uneven. Calyx irregular and fairly large-sized, lobes often not well developed. In cross-section, rind is medium-thin, brittle, oil cells round, very close, segment wall rather thin, rather adherent to rind, except in baggy fruits. Segments numerous, central column rather small and pith fairly abundant and adherent to the segment, pulp rather coarse, hard, and vesicles rather stretched in arrangement and not finely anastomose.

A close examination of these figures will show that this is not identical with the Zairai fruit of Aoe (Tadle 52), which has a thinner rind and thicker segment wall, more abundant pith and is of decidedly inferior quality. The large development of the disk ring is occasionally seen in Owari, as is seen in Lot No. 41. The character of the pulp is

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\* PL. XIII, Fig. 3.

## 200 INDIVIDUALITY AND SELECTION PROBLEM IN THE SATSUMA ORANGE

TABLE 57.

MEASUREMENT OF SATSUMA FRUITS OF OWARI VARIETY IN YAKUSHIJI'S ORCHARD AT TACHIMA, EHIME-KEN. LOT NO. 39 OF 1920. TOTAL NUMBER OF FRUITS, 720 (NOS. 3367-4088).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.62 cm.	4.15 cm.	1.43	73.80 gm.	9.58 mm.	10.92	2.89 mm.	12.74 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	720	—	—	—	—	—	378	52.50%
Sinuate based fruits	709	—	—	—	—	—	249	35.26
Semi-sinuate based fruits	709	—	—	—	—	—	311	43.86
Areolated fruits	720	—	—	—	—	—	359	49.86
Frs. with undeveloped calyx lobes	711	—	—	—	—	—	265	37.27
Frs. with long narrow calyx lobes	711	—	—	—	—	—	14	1.97
Fruits containing seeds	720	—	—	—	—	—	252	35.00
Apical depression	720	270 37.50	275 38.19	169 23.47	6 0.83%	—	—	—
Apical dots	718	97 13.51	304 42.34	317 44.15%	—	—	—	—
Flatness of fruit	720	129 17.92	226 41.11	246 34.17	47 6.53	2 0.28%	—	—
Smoothness of fruit	720	0 0	11 1.53	474 65.83	125 17.36	110 15.28%	—	—
Thinness of rind	718	220 30.64	260 36.21	221 30.78	17 2.37	0 0%	—	—
Thinness of segment wall	720	339 47.08	247 34.31	118 16.39	14 1.94	2 0.28%	—	—
Color of pulp	720	582 80.89	116 16.11	21 2.92	1 0.14	0 0%	—	—
Size of central column	719	3 0.42	22 3.06	417 58.00	227 31.57	50 6.95%	—	—
Quantity of pith	719	11 1.53	88 12.24	440 64.20	138 18.50	47 6.54%	—	—
Quality of pulp	710	69 9.72	253 35.63	335 47.18	49 6.90	4 0.56%	—	—

considerably worse than in the ordinary Owari, but this is possibly due to a severe infection of melanose and its neglected condition, as it receives no fertilizers. The fruit received much bruise during transit, due to poor packing, and deterioration was frequent, but it tasted still better than KAWANO's Aoe Zairai. It is quite presumable that this plant has the same origin as KAGAYAMA's old tree which was multiplied from the plants introduced when the art of grafting first became known to the villagers about 95 years ago. The Hira variety must also have developed about this time, as an extremely flat fruiting individual among them, since these Owari plants themselves have considerably flatter fruits than those of other localities.

### FURTHER DISTRIBUTION OF THE OWARI SATSUMA

In the preceding chapters, the author has given proof of a wide distribution of the Owari Satsuma in western Japan, including the most important Citrus regions such as Ikiriki, Tsukumi, Tachima, and Ôchô (Hiroshima). The Zairai variety, on the other hand, is common in the prefectures of Fukuoka, Nagasaki, and Kagoshima, but does not reach Ehime (Tachima) and Hiroshima. It was also found that in Tachima, the Owari has been known at least two hundred years, according to the record presented by Mr. KAGAYAMA, but since about 1860, the planting of the Kishûnae (Ikeda variety) became popular, and its popularity lasted for some time, until the villagers discovered that the older variety was better. This discovery, however, did not alter their patronage in buying plants from the Ikeda nurseries, but they supplied the bud sticks of Owari (partly Hira) from the village, being dissatisfied with the Ikeda, the only available variety in that region. From about 1890, Owari plants propagated in the Idzumi region (called "Senshûgi") gradually became introduced into Tachima, but they did not win popularity, being no better than the old variety, which was nothing but the Owari. The author's field observations quite agree with this statement, and it was easy to find these Ikeda plants and Idzumi Owari trees in the village, besides the Tachima Owari and Hira Satsuma developed there. The



condition was quite similar in Ôchô, where the Ôchô Owari has existed more than 100 years, and later both Kishû-nae (Ikeda) and Idzumi Owari were introduced.

In extending the field observations in the central, and the eastern part of the main island, many new interesting facts were revealed. In the central region, called the Kinki district, the Ikeda variety was found most popular. Proceeding farther east, we find that Ikeda disappears and Owari takes its place. Of course, the territories of Shidzuoka and Kanagawa have made rapid progress rather recently, and are the chief centers, absorbing the nursery plants of Owari Province. It is, however, evident that the nurserymen in Owari never had any special preference as to the variety they should propagate when they started the nursery business in Citrus, and it is easy to suppose that the Owari variety was in existence about that time, and that they simply took the chance to utilize these local buds of Owari. Furthermore, it is possible that the Owari was the only variety that existed there, which therefore favored the good reputation of the nurseries on account of the complete absence of race mixture. If Owari was the only variety of Satsuma orange which reached the middle-east region, it must have been the sole race proceeding still farther east. This assumption was easily proved true by extending the field observation in Kanagawa and Shidzuoka Prefectures. This study definitely brought to light the fact of the early existence of the Owari variety in these regions.

#### *Owari existed in Shidzuoka Prefecture*

The oldest Satsuma region in the producing center of Shidzuoka Prefecture, is Okabe, according to OSADA<sup>(96)</sup>, but no large tree is now in existence there. The largest trees in the prefecture were found at Iwara in Iwara county. In the orchard of Kuroemon KATAHIRA, at Sugiyama, there were 17 old trees all aged not younger than 77 years in 1920, which had been grafted by the village professional propagator Tôshichi AOKI, who took the scion from a single large Satsuma tree then existing there under the name "Tômikan". One of these trees was used for individuality study, the description of which is given below:

Lot No. 46 of 1920. Old Satsuma tree of Kuroemon KATAHIRA, at Ôba, Sugiyama, in Iwara village. Situated in a hill-side orchard facing S-E, second terrace from the bottom, second tree from the east, with a distance of 6.07 m. from the western tree, 5.2 m. from the eastern. Unpruned, E-W spread 6.63 m., N-S spread 6.92 m., and height 4.33 m. Typical Owari tree with 6 trunks, the union of which is buried under the ground while those above the ground are scattered as much as 1.2 m. apart. All trunks and branches are inclined toward the east, the branches being sparse. Condition of the tree is very healthy; leaves large, erect, and less undulate, except at the inside of the tree, very healthy looking. Soil red, fertile loam without pebbles; well fertilized. The measurements of the total fruits of a representative branch are given in Table 58.\*

The fruit is very typical of the Owari, having a conical outline and deeply depressed, grooved base. The size is medium, apex greatly depressed, but the areola not frequent, and navel prominent. Calyx large, well developed and deep-colored, surrounding area deeply and gradually concave, shortly grooved. The horizontal outline is somewhat irregular, uneven, surface quite greasy, with fine dots both concave and convex. The condition in full maturity is without blemishes, with slight bagginess. In the cross-section, rind is quite uniform in thickness being medium-thin and the segment wall is extremely thin. Central column is uniformly medium-large with rather little quantity of pith. Pulp is more or less lighter than "deep-colored" grade, finely grained, fruit soft, juicy, flavor very insipid due to the over-ripe condition. The segments mostly very uniform in shape, outer margins being emarginate, corners angular or often rounded, inner ends always normally rounded. These characters are all typical of the Owari variety.

In Shidzuoka Prefecture, a few small lots of Satsuma orange came under observation in various places, but they all proved to be Owari. A plant which was studied under the suspicion of displaying a limb variation, is taken for an example. This plant belongs to Teizô SUZUKI,

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\* PL. XIII, Fig. 4.

TABLE 58.

MEASUREMENT OF FRUITS FROM OLD OWARI SATSUMA OF KATAHIRA'S  
ORCHARD AT IWARA, SHIDZUOKA PREFECTURE. LOT NO. 1920.  
TOTAL NUMBER OF FRUITS, 117 (NOS. 1799-1915).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.43 cm.	4.36 cm.	1.42	84.27 gm.	10.21 mm.	10.63	2.95 mm.	14.81 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	117	—	—	—	—	—	72	61.54%
Sinuate based fruits	117	—	—	—	—	—	3	2.56
Semi-sinuate based fruits	117	—	—	—	—	—	43	36.75
Areolated fruits	117	—	—	—	—	—	21	17.95
Frs. with undeveloped calyx lobes	116	—	—	—	—	—	16	13.79
Frs. with long narrow calyx lobes	116	—	—	—	—	—	3	2.59
Fruits containing seeds	117	—	—	—	—	—	1	0.85
Apical depression	117	53 45.30	53 45.30	11 9.40	0 0%	—	—	—
Apical dots	117	6 5.13	15 12.82	96 82.05%	—	—	—	—
Flatness of fruit	117	57 48.72	50 42.74	9 7.69	1 0.85	0 0%	—	—
Smoothness of fruit	117	0 0	34 29.06	83 70.94	0 0	0 0%	—	—
Thinness of rind	117	52 44.44	32 27.35	30 25.64	3 2.56	0 0%	—	—
Thinness of segment wall	117	100 85.47	17 14.53	0 0	0 0	0 0%	—	—
Color of pulp	117	40 34.19	71 60.68	5 4.27	1 0.85	0 0%	—	—
Size of central column	117	6 5.12	33 28.21	75 64.10	3 2.56	0 0%	—	—
Quantity of pith	117	0 0	8 6.84	73 62.39	29 24.79	7 5.98%	—	—
Quality of pulp	117	1 0.86	11 9.48	97 83.62	7 6.03	0 0%	—	—

at Sangenya, Mariko, Osada-mura, Abe-gun, Shidzuoko-ken, and is briefly described below :

Lot No. 45 of 1920. Owari tree in SUZUKI's orchard, 180 meters from sea level, called the Funakawa-no-Tani orchard. A hill-top tree, planted on a narrow terrace, about 1.7 m. wide, distance from other trees 2.46 m., 22 years after being planted, having E-W spread, 3.46 m., N-S spread, 3.46 m., and height, 3.46 m. Crowded with neighbouring trees, but good shape, branches rather upright, leaves large, broad, less upright, and rather hanging. Soil good, very fertile, calcareous, heavily mulched, and fertilized with sesame oil press cake and bone dust. Colored early at the top of the tree, which is well exposed to the sun-light, so that these uppermost branches were thought to be a limb variation, but close observations disproved it. The fruits were taken for determination and were measured as shown in Table 59.\* The entire crop of a single limb in question was used for study.

Fruits are medium-small in size and medium-flat in shape, regular in outline, surface even or smooth. Base of fruit shallowly crater-like, as typical of Owari, and not sinuate nor flat: the calyx is regularly large and the lobes well developed. Apex of fruit depressed, navel developed in half of the fruits, areola rather prominent. Tight-skinned and not fully mature when examined, with a few green spots. In cross-section, the rind is medium, segment wall rather thin, pulp deep-colored, central column rather small and amount of pith medium. Quality of pulp is fair, although date of observation was rather early (Nov. 11, 1920).

There have been several other individuals of the Owari variety in Shidzuoka Prefecture which came under observation, these are given in the chapter discussing the bud variation problem.

#### *Owari existed in Kanagawa Prefecture*

The survey work carried out in Kanagawa Prefecture brought some old Owari trees under investigation. These were found in the Kajiya

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\* PL. XV, Fig. 1.

TABLE 59.

MEASUREMENT OF SASUMA FRUITS OF SUZUKI'S OWARI AT MARIKO, OSADA-MURA, SHIDZUOKA-KEN. LOT NO. 45 OF 1920. TOTAL NUMBER OF FRUITS, 20 (NOS. 1731-1750).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.14 cm.	4.15 cm.	1.35	72.45 gm.	10.20 mm.	10.35	3.16 mm.	11.53 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	20	—	—	—	—	—	10	50.00
sinuate based fruits	20	—	—	—	—	—	0	0
semi-sinuate based fruits	20	—	—	—	—	—	6	30.00
Areolated fruits	20	—	—	—	—	—	10	50.00
Frs. with undeveloped calyx lobes	20	—	—	—	—	—	8	40.00
Frs. with long narrow calyx lobes	20	—	—	—	—	—	1	5.00
Fruits containing seeds	20	—	—	—	—	—	3	15.00
Apical depression	20	1 5.00	10 50.00	9 45.00	0 0%	—	—	—
Apical dots	20	0 0	1 5.00	19 95.00%	—	—	—	—
Flatness of fruit	20	0 0	10 50.00	9 45.00	1 5.00	0 0%	—	—
Smoothness of fruit	20	2 10.00	9 45.00	9 45.00	0 0	0 0%	—	—
Thinness of rind	20	1 5.00	3 15.00	10 50.00	6 30.00	0 0%	—	—
Thinness of segment wall	20	4 20.00	12 60.00	3 15.00	0 0	1 5.00%	—	—
Color of pulp	20	17 85.00	3 15.00	0 0	0 0	0 0%	—	—
Size of central column	20	0 0	1 5.00	7 35.00	11 55.00	1 5.00%	—	—
Quantity of pith	20	0 0	6 30.00	10 50.00	4 20.00	0 0%	—	—
Quality of pulp	20	2 10.00	7 35.00	11 55.00	0 0	0 0%	—	—

region of Yoshihama village in Ashigarashimo county, and their origin is quite unknown. The local growers have practiced grafting the Satsuma orange on to trifoliate orange for many years, so that they do not have to buy nursery plants from other localities. A tree in an orchard of Tsuruichi KASHIWAGI has an enormous size but the plant of Sakujirô TOKIWA, used for study, has a still larger volume though it is not so wide-spreading as the former. Still, a few other trees a little smaller in size are seen scattered here and there in the vicinity, giving a suggestion that this region is undoubtedly the center of an old Satsuma planting. The description of the tree brought under observation is as follows:

Lot No. 41 of 1930. TOKIWA's old Owari Satsuma at Ozaki orchard, Kajiya, Yoshihama-mura, on a foothill forming very slow slope dipping toward S-E. Tree is unpruned, is standing on the road side, is older than 50 years, and is surrounded by young trees. It has an E-W spread of 7.79 m., N-S spread of 7.21 m., and height of 4.91 m. Large-sized, of spherical shape with thick, stout trunk, 1.28 m. in girth above the union, and 1.60 m. in girth on the surface of the stock. Branches rather few in number, straight, and gradually spreading, drooping at the ends but the smaller shoots are almost upright in position. Leaves dense, large, deep-colored, hanging, undulate and broad. Soil very fertile, being black loam with a small amount of pebbles, and mulched with straw. Fertilized with stable manure, bone dust, fish manure, and superphosphate, costing 4 yen per tree. The plant seems to have come from the Maegawa region, and only this variety is grown in this region. The picking season is from October 25 to December 25. Selling price per box varies from 5.50 yen early in the season, 3.00-3.50 at mid season, and 4.00 after a short storage. The measurements of fruits from one branch of this tree are given in Table 60.\*

The fruits are medium-large, ranging from large to small, shape medium-flat, outline very irregular. Surface undulate, more or less uneven, harsh, probably caused by bagginess through late picking. Apex very much depressed, with generally prominent areola and well developed

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\* PL. XIV, Fig. 1.

TABLE 60.

MEASUREMENT OF FRUITS OF TOKIWA'S OWARI SATSUMA AT YOSHIHAMA,  
KANAGAWA PREFECTURE. LOT NO. 41 OF 1920. TOTAL NUMBER  
OF FRUITS, 141 (NOS. 1918-2058).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.75 cm.	4.68 cm.	1.40	94.60 gm.	10.08 mm.	11.06	2.94 mm.	12.72 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	141	—	—	—	—	—	89	% 63.12
Sinuate based fruits	141	—	—	—	—	—	1	0.71
Semi-sinuate based fruits	141	—	—	—	—	—	15	10.64
Areolated fruits	141	—	—	—	—	—	95	67.38
Frs. with undeveloped calyx lobes	141	—	—	—	—	—	45	31.91
Frs. with long narrow calyx lobes	141	—	—	—	—	—	0	0
Fruits containing seeds	141	—	—	—	—	—	2	1.41
Apical depression	141	111 78.72	27 19.15	3 2.13	0 0%	—	—	—
Apical dots	141	2 1.42	36 25.53	103 73.05%	—	—	—	—
Flatness of fruit	141	64 45.39	57 40.43	17 12.06	3 2.13	0 0%	—	—
Smoothness of fruit	141	0 0	19 13.48	111 78.72	11 7.80%	—	—	—
Thinness of rind	141	1 0.71	13 9.22	75 53.19	32 22.71	20 14.18%	—	—
Thinness of segment wall	141	93 65.96	43 30.50	5 3.55	0 0	0 0%	—	—
Color of pulp	141	4 2.84	96 68.09	41 29.08	0 0	0 0%	—	—
Size of central column	141	9 6.38	88 62.41	44 31.21	0 0	0 0%	—	—
Quantity of pith	141	0 0	7 4.96	109 77.30	25 17.73	0 0%	—	—
Quality of pulp	141	0 0	13 9.22	113 80.14	15 10.64	0 0%	—	—

navel. Base also deeply depressed, with conspicuous deep and long furrows. Calyx large, beautifully green colored, only less developed in smaller fruits. Disk large, disclosed in larger fruits. In cross-section, rind is very thick, conspicuously puffy, oil cells are large and elongated, heaped in rows. Segment wall thin, soft and wavy, its outer margin and corner rounded, inner end small and rather rounded. Central column rather large and pith rather little. Pulp color lighter, extremely juicy and fine grained, vesicle wall being thin and inconspicuous. Quality of pulp is only fair, insipid and somewhat acidulous, almost like KATAHIRA's Owari. In every respect, this lot agrees with the characters of Owari.

In Maegawa, to which region the origin of this tree is attributed, the Satsuma and other Citrus were known for a very long period, and there are a few old trees of Satsuma orange. A few sample fruits were collected in the orchard of Kunitarô SHINO, whose grandfather obtained a Satsuma plant from one HATTORI, a secretary of the old feudal lord. The original plant is said to have come from Kumamoto and the present tree, about 70 years old, is one of the second generation trees propagated from the original one. This statement agrees with the information obtained by Mr. TOKIWA of Yoshihama. Maegawa has been celebrated for Kinokuni oranges from very old times, but is also famous for producing Satsumas having a very thin, polished skin. The latter is said to be caused by a very shallow but extremely fertile soil, with particular reference to the constituents of the underlying rock.

The sample fruits (Lot No. 70 of 1920, 7 fruits) have a girth of 20.85 cm.; height, 4.35 cm.; D/H index, 1.53; weight, 102.5 gm.; calyx, 10.67 mm.; number of segments, 11.67; rind, 2.46 mm.; central column 15.92 mm. The fruit is tight-skinned, beautifully flattened, gradually and broadly depressed at both ends, less grooved at the base; navel is prominent, areola less developed, and none have sinuate base. There are no fruits with undeveloped calyx lobes all being well developed. In cross-section, the rind is thin, central column rather small, segment wall thin, pulp deep-colored and very pleasantly sweet. It is remarkable that the quality of Owari fruit is so closely correlated with the condition



of the soil, and the fruit is even earlier in ripening than anywhere else where the soil is less fertile.

*Owari existed in Ôsaka Prefecture*

The final question about the distribution of Owari Satsuma is to confirm its occurrence in the central part of the Citrus districts of Japan, mainly in Ôsaka and Wakayama Prefectures. These places were unquestionably under the influence of the nurseries of the Ikeda region, and the Ikeda variety unquestionably predominated in large parts of the orchards, before the activity of the nurseries of Owari Province reached here through the Idzumi nurserymen. It is, however, conceivable that before the Owari variety reached the eastern growing sections from its western home, it had a chance to reach this region. A critical search was first made, with an aid of the Ôsaka Agricultural Experiment Station, in orchards of Idzumi Province (Ôsaka-fu), in the hope of locating some old plant of Owari Satsuma surviving in certain protected areas. Although the survey was then extended to Wakayama Prefecture, very old Satsumas were only found in Iorinoyama, Yamataki-mura, Senhoku-gun (Idzumi prov.), Ôsaka-fu. A plant studied in this place is aged 140 years, unquestionably having been distributed from the Ikeda region. This plant was found in the orchard of Kahei AKASAKA, and about ten plants of the same age were in association with it. The detailed description of this tree is as follows:

Lot No. 47 of 1920. AKASAKA's old Satsuma tree in Toridani orchard, Iorinoyama. Located on a slope dipping toward E-E-W, being the largest tree on the hill ridge, north of the road. It is a large, unpruned tree, rather weak-looking, planted at distances of 4.04 m. from the northern tree, 5.20 m. from the southern, and having E-W spread, 4.6 m., N-S spread, 5.20 m., and height, 3.46 m. Trunk is thick, divided into 4 parts above the ground, branches many, thin, crowded. Leaves smaller, dense, upright on upper branches, hanging on lower branches, boat-shaped and rather pointed at both ends. Soil very shallow, hard pan below pebbled loam, so that the tree is much dwarfed and

TABLE 61.

MEASUREMENT OF SATSUMA FRUITS OF AKASAKA'S OLD OWARI TREE AT  
YAMATAKI-MURA, IDZUMI PROVINCE. LOT NO. 47 OF 1920. TOTAL  
NUMBER OF FRUITS, 186 (NOS. 2337-2522).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.05 cm.	4.33 cm.	1.47	83.77 gm.	9.83 mm.	10.46	2.55 mm.	13.58 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	186	—	—	—	—	—	36	19.35%
Sinuate based fruits	186	—	—	—	—	—	37	19.89
Semi-sinuate based fruits	186	—	—	—	—	—	120	64.52
Areolated fruits	186	—	—	—	—	—	163	87.63
Frs. with undeveloped calyx lobes	183	—	—	—	—	—	31	16.94
Frs. with long narrow calyx lobes	183	—	—	—	—	—	2	1.09
Fruits containing seeds	186	—	—	—	—	—	8	4.30
Apical depression	186	73 39.25	72 38.71	41 22.04	0 0%	—	—	—
Apical dots	185	16 8.65	103 55.68	66 35.68%	—	—	—	—
Flatness of fruit	186	46 24.73	102 54.84	37 19.89	1 0.54	0 0%	—	—
Smoothness of fruit	186	3 1.61	46 24.73	111 59.68	11 5.91	15 8.06%	—	—
Thinness of rinp	186	125 67.20	55 29.57	6 3.23	0 0	0 0%	—	—
Thinness of segment wall	186	159 85.48	22 11.83	5 2.69	0 0	0 0%	—	—
Color of pulp	186	142 76.34	36 19.35	6 3.23	2 1.08	0 0%	—	—
Size of central column	185	0 0	16 8.65	139 75.14	28 15.14	2 1.08%	—	—
Quantity of pith	186	1 0.54	8 4.30	157 84.41	18 9.68	2 1.08%	—	—
Quality of pulp	186	26 13.98	77 41.40	71 38.17	7 3.76	5 2.69%	—	—

old-looking on this account, and also due to attacks of cold wind. Fertilized with rape seed cake, bean cake, and night soil. A crop of one large branch was used for study. The measurements of fruits are given in Table 61.\*

The fruit is rather uniformly large and tight-skinned, outline rather regular, base not much depressed nor grooved, apex much depressed, areola well developed, surface deep-colored, uniformly finely pitted. Calyx large, lobes rather irregular and thick. Navel not prominent. In cross-section, it has rather thin rind of uniform dimensions, thin segment wall which is not very tenacious, outer corner not rounded, inner end rounded, with medium or rather little amount of pith which is rather solid in texture. Central column medium-sized, pulp deep-colored, flavor fair but often acidulous, meaty, coarse grained, and not tenacious, vesicles being stretched lengthwise and slightly hard. No puffy fruit occurs, and the quality of pulp seems to be rather affected by age and by the poor condition of the soil and nutrition. The character of the fruit is exactly similar to that of the lately introduced Owari trees, especially those on Yuzu stock (Table 63), grown on similar shallow soil, so that there is no hesitation in identifying this old individual as Owari variety. Confirmation is given by comparing these with the fruits of two trees of lately-introduced Owari plants in the orchard of Shôemon KAWAKAMI not far from AKASAKA's old tree. Details of these tree are given as follows:

Lot No. 24 and 25 of 1920. KAWAKAMI's Owari Satsuma on trifoliate stock, in Toridani (Madani) orchard, Yamataki-mura, Senhokugun, Ôsaka-fu. It stands on a slope inclined toward south-east, located at the northern side of the road, 10th tree from above, planted as a 4-year old tree in 1890 at the distance of 3.46 m. from other trees. This is a moderately large sized tree, having E-W spread, 4.13 m., N-S spread, 1.54 m. and height, 3.46 m., with upright habit, drooping only at the end of branches, most of the branchlets either bending or upright. Leaves dense, upright, deep-colored, broad and more or less boat-shaped,

not hanging. Soil, clayey loam without pebbles, surface soil deep. Mulched with straw, fertilized with dried herring, soy bean cake and bone dust, 2.5 shô (4.5 litres) per tree. There are about 2000 trees of the same age, introduced from Ibori, Inagaya-mura, Nakajima-gun, Aichi-ken (Owari Province), through Sukekurô KONDÔ, nurseryman, under the name "Kairyô Unshû" or "Owari-nae", being the genuine Owari Satsuma. The picking season is from the beginning to the middle of December, the fruit is not good for storing purposes, because its color fades rather quickly. Price on tree, 5 yen per 1 pikul (16 kwan or 60 kg.) Nursery plants frequently bear thorns. The measurements of fruits are given in Table 62.\*

Fruits medium-sized, more or less compact and sharply pitted. Average shape medium-flat, outline being more or less irregular. Apex mostly with broadly and deeply pitted areola, inside of which is deeply depressed with abruptly sunken margin. Navel less prominent, dots mostly reaching to the styler point. Base rather strongly depressed, but not very broad, so that the depression is classed in the semi-sinuate grade, radial grooves not well developed. Calyx large, lobes rather well developed. In sections of fruits, rind is uniform in thickness, medium in larger fruits, thin in smaller ones; central column medium in size, segment wall thin, inner end obtuse, outer corner angular or rounded in some fruits, segment rather regular in shape, easily separable. Pulp deep-colored, juicy, soft, rather good flavor. Pulp vesicles fine grained, wall of which is quite indistinct. Pith uniformly medium in quantity. A few large fruits were becoming slightly puffy.

In another orchard of Mr. KAWAKAMI, a few Owari Satsuma plants grafted on Yuzu stock were found, which gave an opportunity to study the behavior of Owari fruit on a different kind of root-stock. One tree in Iorinoyama orchard was used for study. There are several other individuals in the same orchard, but about 110 plants are in the Sanban orchard. The description of the tree used for study is as follows:

Lot No. 26 of 1920. KAWAKAMI's Owari plant on Yuzu stock, in

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\* PL. XIV, Fig. 3 & 4.

TABLE 62.

MEASUREMENT OF FRUITS OF KAWAKAMI'S OWARI SATSUMA ON TRIFOLIATE STOCK, IN IDZUMI PROVINCE. LOT NO. 24-25 OF 1920. TOTAL NUMBER OF FRUITS, 99 (NOS. 2076-2125, 3072-3120).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.01 cm.	4.10 cm.	1.43	78.97 gm.	10.25 mm.	10.71	3.01 mm.	14.53 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	99	—	—	—	—	—	31	31.31%
Sinuate based fruits	99	—	—	—	—	—	10	10.10
Semi-sinuate based fruits	99	—	—	—	—	—	78	78.79
Areolated fruits	99	—	—	—	—	—	61	61.62
Frs. with undeveloped calyx lobes	99	—	—	—	—	—	14	14.14
Frs. with long narrow calyx lobes	99	—	—	—	—	—	2	2.02
Fruits containing seeds	99	—	—	—	—	—	0	0
Apical depression	99	27 27.27	54 54.55	18 18.18	0 0%	—	—	—
Apical dots	98	0 0	9 9.18	89 90.82%	—	—	—	—
Flatness of fruit	99	41 41.41	43 43.43	14 14.14	0 0	1 1.01%	—	—
Smoothness of fruit	99	3 3.03	29 29.29	48 48.48	19 19.19%		—	—
Thinness of wall	99	32 32.32	31 31.31	29 29.29	6 6.06	1 1.01%	—	—
Thinness of wall	99	71 71.72	24 24.24	3 3.03	1 1.01	0 0%	—	—
Color of pulp	99	55 55.56	39 39.39	4 4.04	1 1.01	0 0%	—	—
Size of central cores	99	6 6.06	15 15.15	64 64.65	14 14.14	0 0%	—	—
Quantity of pith	99	1 1.01	10 10.10	84 84.85	4 4.04	0 0%	—	—
Quality of pulp	97	7 7.22	33 34.02	55 56.71	2 2.06	0 0%	—	—

Iorinoyama orchard, a slope inclined toward S-S-E. The location of the tree is on the second row from the north, 4th tree from the west, distance from the western tree, 2.88 m., from the eastern, 4.04 m., from the southern, 3.16 m. Tree is medium-sized, 18 years after planting, having E-W spread, 2.03 m., N-S spread, 2.47 m., and height, 2.45 m., of upright habit, very loose branched, many branches being upright, only a few being more or less horizontal, even at the upper part of the tree. Leaves large, all hanging, deep-colored, rather thin and undulate. Soil is loam with a small amount of pebbles; fertilized with a mixture of pulverized dried fish, soy bean cake, and superphosphate, about 1 shô (2.19 litre) applied to each tree. Origin of the scion is the tree introduced with the former lot. Ripening season same as the trees on trifoliate stock. Price of fruit in December (on tree) 4.60 yen per 10 kwan (37.5 kg.) The owner's remarks on the Owari fruit borne on trees of Yuzu stock are as follows: (1) Fruits larger, good quality and not easily becoming puffy; (2) trees is not readily affected by stem-borer insect, and resistant to red spider; (3) trees thrive on clayey soil or shallow soil underlaid by a hard pan, on which trifoliate root behaves very poorly; (4) fruiting branches are longer, with few flowers, but a large percentage of them develop into fruit; (5) color of the rind is lighter and keeping quality is slightly inferior. Some points in this statement were proved by the author's observation. The measurements of fruits are given in Table 63.\*

Fruits are large-sized, more or less uniform in shape and outline, base not deeply depressed, less prominently grooved. Apex rather much depressed, areola prominent, navel mostly closed. Surface even, only finely pitted, deep-colored. Calyx large, beautifully green colored, both body and lobes well developed, the latter being thin and very regularly triangular with sharp points. Fruit turgid but soft, not baggy, no blemishes. In cross-section, rind is thick in large fruits, decreasing gradually in the smaller ones. Segment regular in shape, wall thin, often wavy, tenacious, corner not much rounded, inner end more or less pointed. Central column rather small and pith little in quantity. Pulp

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\* PL XV, Fig. 2.

TABLE 63.

MEASUREMENT OF FRUITS OF KAWAKAMPS OWARI SATSUMA ON YUZU  
STOCK, IN IDZUMI PROVINCE, LOT NO. 26 OF 1920. TOTAL  
NUMBER OF FRUITS, 150 (NOS. 2186-2335).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.55 cm.	4.18 cm.	1.41	77.05 gm.	9.61 mm.	9.60	2.67 mm.	12.53 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	150	—	—	—	—	—	15	10.00
Sinuate based fruits	150	—	—	—	—	—	21	14.00
Semi-sinuate based fruits	150	—	—	—	—	—	112	74.67
Areolated fruits	150	—	—	—	—	—	103	68.67
Frs. with undeveloped calyx lobes	150	—	—	—	—	—	50	33.33
Frs. with long narrow calyx lobes	150	—	—	—	—	—	0	0
Fruits containing seeds	150	—	—	—	—	—	5	3.33
Apical depression	150	42 28.00	79 52.67	26 17.33	3 2.00%	—	—	—
Apical dots	150	0 0	15 10.00	135 90.00%	—	—	—	—
Flatness of fruit	150	47 31.33	86 57.33	17 11.33	0 0	0 0%	—	—
Smoothness of fruit	150	17 11.33	49 32.67	66 44.00	15 10.00	3 2.00%	—	—
Thinness of rind	149	103 69.13	37 24.83	7 4.70	2 1.34	0 0%	—	—
Thinness of segment wall	149	128 85.91	17 11.41	4 2.68	0 0	0 0%	—	—
Color of pulp	149	64 42.95	73 48.99	10 6.71	2 1.34	0 0%	—	—
Size of central column	149	0 0	4 2.68	111 74.50	30 20.13	4 2.68%	—	—
Quantity of pith	149	0 0	1 0.67	134 89.93	14 9.40	0 0%	—	—
Quality of pulp	149	16 10.74	70 46.98	56 37.58	5 3.36	2 1.34%	—	—

extremely soft and juicy, fair in quality, vesicles anastomosing, their wall being thin. Comparing this table with Table 61 (AKASAKA'S 140 years old Satsuma), we find a wonderful similarity of both lots, except in the minor characters of the pulp of the latter, affected by age and poor conditions.

*Mixture of varieties in Ōsaka Prefecture*

During the survey of Owari Satsuma in Idzumi province, it was supposed that some other varieties might have been unconsciously propagated in the Ikeda nurseries, thereby resulting in a mixed planting of a few plants among a large lot of Ikedas. Because of this, attention was called to the presence of a flat fruiting tree in MINAMI'S Ikeda orchard.

This tree was chosen as a sample tree and the fruits were picked for measurement. The detail of the tree is given below:

Lot No. 48 of 1920. Flat fruiting tree in the Ikeda orchard of Torajirô MINAMI, at Shirooka, Yamataki-mura, which is thickly planted in a valley about 17.40 m. wide, slanting northward. This is the 5th tree from the north-west on a landside, planted at a distance of 3.17 m. from the western tree, 3.05 m. from the eastern, and 3.05 m. from the northern. It is about 40 years old, has E-W spread, 46.7 m., N-S spread, 4.04 m., and height, 3.46 m. Branches are thick, irregular in direction, central ones more or less upright, surrounding ones bending abruptly, hanging only at northeastern side, generally upright at all other parts. Leaves more or less small (affected by frost), larger ones broad and hanging, less undulate, upright on the upper part, not crowded. Soil, loamy clay, hard, almost no pebbles. No mulch, weedy ground, rather poorly kept, interplanted with tea-plants. Picking season after December 10th. The only flat fruiting tree in this plot. The measurements of fruits of the whole tree are given in Table 64.\*

Fruits are rather large in size, smaller fruits few. Generally scabby and poor looking. Shape flat to medium-flat, outline regular, often abnormally tall but generally looking flat due to expansion on the

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\* PL. XV, Fig. 3.



TABLE 64.

MEASUREMENT OF SATSUMA FRUITS OF MINAMI'S FLAT FRUITING TREE  
(ZAIRAI), IN IDZUMI PROVINCE. LOT NO. 48 OF 1920. TOTAL  
NUMBER OF FRUITS, 406 (NOS. 2523-2923).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.87 cm.	4.36 cm.	1.38	84.64 gm.	10.28 mm.	10.39	2.77 mm.	12.52 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	406	—	—	—	—	—	72	17.73%
Sinuate based fruits	406	—	—	—	—	—	288	70.94
Semi-sinuate based fruits	406	—	—	—	—	—	36	8.87
Areolated fruits	406	—	—	—	—	—	272	66.99
Frs. with undeveloped calyx lobes	397	—	—	—	—	—	45	11.34
Frs. with long narrow calyx lobes	397	—	—	—	—	—	49	12.34
Fruits containing seeds	406	—	—	—	—	—	38	9.36
Apical depression	406	21 5.17	85 20.94	271 66.75	29 7.14%	—	—	—
Apical dots	404	6 1.49	97 24.01	301 74.50%	—	—	—	—
Flatness of fruit	406	54 13.30	172 42.36	158 38.92	22 5.42	0 0%	—	—
Smoothness of fruit	405	18 4.44	121 29.88	181 44.69	50 12.35	35 8.64%	—	—
Thinness of rind	405	213 52.59	112 27.65	72 17.78	7 1.73	1 0.25%	—	—
Thinness of segment wall	405	174 42.96	186 45.93	40 9.88	5 1.23	0 0%	—	—
Color of pulp	405	269 66.42	87 21.48	44 10.86	5 1.23	0 0%	—	—
Size of central column	405	0 0	35 8.64	261 64.44	86 21.23	23 5.63%	—	—
Quantity of pith	404	19 4.70	117 28.96	258 63.86	10 2.48	0 0%	—	—
Quality of pulp	404	72 17.82	183 45.30	118 29.21	25 6.19	6 1.49%	—	—

equatorial sides. Surface compact and roughly pitted, apex not much depressed, areola rather prominent, navel not conspicuous. Base rather sinuate, calyx medium, lobes moderately developed, very frequently with elongated tips, those with undeveloped lobes few. Tight-skinned with a large number of late-bloom fruits. In cross-section, rind thin, oil cells round, dispersed, segment wall rather thick, adherent with each other, not rounded at outer corner, central column smaller than medium, pith rather abundant, attached to the inner end of the segment. Pulp intensely colored, rather coarsely grained, flavor intense, acidulous.

In all respects, these fruits are not Owari, although when observed on tree the outline is uniformly flat from the early period of development. A great abundance of sinuate based fruit, tight-skin, hard in texture, little depression at the apex, thick segment wall and solid pulp with coarse grained vesicles, etc. are typical of Zairai variety. At the time when the survey was made with the aid of Prof. T. MIKI, this tree attracted much attention, and was thought to be a variation of Ikeda. Since the Ikeda is considered to have been derived from the Zairai, as was discussed before, it is quite probable that a Zairai tree may occur by chance among several thousands of Ikeda individuals. MINAMI's case is considered to be such, and this agrees with the expectation that a few Zairai can be detected in a large number of Ikeda individuals. It is also confirmed that Owari never does appear in this way, and when plants of Owari and Ikeda are mixed-planted, their origin is definitely different, as we have noticed in Tachima and Ôchô. It is, therefore, concluded that the Owari reached here to Idzumi Province at a very ancient period before the activity of the nurseries of the Ikeda district had commenced, and with the introduction of their plants, the Ikeda variety was planted, with a very few exceptions of a mixture of the Zairai variety among them.

#### *Owari in Wakayama Prefecture*

In Wakayama Prefecture, several Ikeda plants were investigated in connection with variegation and willow-leaf variation. A search was made

to located particularly large flat-fruited types of Satsuma, and the writer was informed by the staff of the Citrus sub-station of the Prefectural Agricultural Experiment Station, that such a plant exists in the orchard of Fusakichi TANIGUCHI, at Yasuda-mura, Arita-gun, Wakayama-ken. A close study of this tree proved it nothing but an Owari. It is evident that such an Owari individual propagated locally for many years is a proof of the early existence of the Owari variety in this prefecture also. A description of this plant is given as follows, though an extensive study was impossible because only second picks were left on the tree.

Lot No. 69 of 1920. TANIGUCHI's large-fruited Satsuma (Owari). It is a tree about 17 years old being a purchased tree of unknown origin, probably propagated locally. It has E-W spread of 3.33 m., N-S spread of 3.5 m., and height of 2.87 m., with four trunks united at the bottom. Branches upright; they are horizontal on the western side, but not drooping in any direction. Leaves large, hanging, with broad lamina. Only 5 fruits were left unpicked when the tree was visited. These fruits were measured as shown in Table 65. Soil loam, with pebbles, mulched with sedges. Fertilizers constitute of herring press cake 60 kwan (225 kg.) and wood ash 20-30 kwan (75-112.5 kg.).

Fruits are not particularly large but are tight-skinned, devoid of areola, with normal calyx. Both rind and segment wall thin, central column medium-sized, with medium amount of pith. Pulp deep-colored and good quality. These characters agree with the Owari, and it is supposed that such Owari is highly esteemed in this old Ikeda region, on account of its rarity and its better size and quality.

## IKEDA VARIETY AND ITS VARIATION

### *Wrinkled Satsumas*

In the course of the study in the individuality of the plant representing a certain variety of the Satsuma orange, the author met several cases of variation, among which the fruit with a wrinkled surface occurred most frequently. This kind of variation appeared in both the Ikeda and

TABLE 65.

MEASUREMENT OF SATSUMA FRUITS OF TANIGUCHI'S LARGE FRUITING INDIVIDUAL (OWARI) IN WAKAYAMA PREFECTURE. LOT NO. 69 OF 1920.  
TOTAL NUMBER OF FRUITS, 5 (NOS. 6234-6238).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.00 cm.	3.98 cm.	1.44	69.40 gm.	10.60 mm.	11.20	2.19 mm.	12.50 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	5	—	—	—	—	—	3	% 60.00
Sinuate based fruits	5	—	—	—	—	—	1	20.00
Semi-sinuate based fruits	5	—	—	—	—	—	4	80.00
Areolated fruits	5	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	5	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	5	—	—	—	—	—	0	0
Fruits containing seeds	5	—	—	—	—	—	0	0
Apical depression	5	0 0	0 0	5 100.00	0 0%	—	—	—
Apical dots	5	0 0	1 20.00	4 80.00%	—	—	—	—
Flatness of fruit	5	0 0	4 80.00	1 20.00	0 0	0 0%	—	—
Smoothness of fruit	5	0 0	4 80.00	1 20.00	0 0	0 0%	—	—
Thinness of rind	5	4 80.00	0 0	1 20.00	0 0	0 0%	—	—
Thinness of segment wall	5	4 80.00	0 0	1 20.00	0 0	0 0%	—	—
Color of pulp	5	4 80.00	1 20.00	0 0	0 0	0 0%	—	—
Size of central column	5	0 0	0 0	4 80.00	1 20.00	0 0%	—	—
Quantity of pith	5	0 0	1 20.00	4 80.00	0 0	0 0%	—	—
Quality of pulp	5	2 40.00	2 40.00	0 0	1 20.00	0 0%	—	—

the Owari varieties. The first record was taken in Ikiriki village, where a conspicuously wrinkled-fruited Satsuma tree was located in the house garden of the village master, Mr. Kenzaburō OGATA. This tree, together with other normal Satsumas, were purchased from Heiemon SAKAUE of the Ikeda nursery district in 1896. The plant is briefly described as follows:

Lot No. 12 of 1919. Wrinkled Ikeda tree in Mr. OGATA's garden, at Matsuda, Funatsu-gō, Ikiriki-mura, Nagasaki Prefecture. It stands in front of a Japanese garden, being the second tree from the west, 2.33 m. from the first. It has an E-W spread of 3.60 m., N-S spread of 3.17 m., and height of 2.47 m. Branches spreading, thin, more or less drooping; leaves smaller, narrow, undulate, attached loosely, pointed at the apex, somewhat reflexed. Measurements of all the fruits of the tree are given in Table 66.\*

The fruit of this lot has beautiful longitudinal wrinkles on the surface, varying in degree as classed in the table. The outline is rather flat with little depression at both ends, with rather well developed areola and fairly conspicuous navels. Calyx is peculiar, with tips of lobes elongated. Rind thin and segment wall moderately thin with rather abundant pith. Pulp is deep-colored and the quality is moderately good.

The plant was bought as an Ikeda with other individuals and its general characters agree with the identification, but the outline of fruit is more flat than in the common Ikeda. It seems that the wrinkled character also causes the flattening of the fruit. This was verified by studying the wrinkled Owari, which is frequently seen in orchards which are more or less abnormal in condition. Many individuals of such wrinkled Owari were seen in the Hōkwaen orchard in Kagoshima city and in TAKANO's orchard at Tarumidzu, Kimotsuki-gun, Kagoshima Prefecture. As an example of such a very flat wrinkled Owari, the following lot is chosen to give a comparison with Mr. OGATA's plant.

Lot No. 19 of 1919. Wrinkled Owari tree in the Hōkwaen orchard, Yashirō SETOGUCHI, proprietor, at Yoshino-mura near Kagoshima city. It

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\* PL. XV, Fig. 4.

TABLE 66.

MEASUREMENT OF IKEDA SATSUMA FRUITS (WRINKLED INDIVIDUAL) FROM  
OGATA'S GARDEN AT IKIRIKI, NAGASAKI PREFECTURE. LOT NO.

12 OF 1919. TOTAL NUMBER OF FRUITS, 205.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.89 cm.	4.14 cm.	1.38	71.51 gm.	—	11.27	2.19 mm.	12.86 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	203	—	—	—	—	—	50	% 24.63
Sinuate based fruits	203	—	—	—	—	—	26	12.81
Semi-sinuate based fruits	203	—	—	—	—	—	0	0
Areolated fruits	205	—	—	—	—	—	104	50.73
Frs. with undeveloped calyx lobes	114	—	—	—	—	—	7	6.14
Frs. with long narrow calyx lobes	114	—	—	—	—	—	36	31.58
Fruits containing seeds	205	—	—	—	—	—	20	9.76
Apical depression	201	12 5.97	58 28.86	92 45.77	39 19.40%	—	—	—
Apical dots	202	11 5.45	126 62.38	65 32.18%	—	—	—	—
Flatness of fruit	203	33 16.26	127 62.56	40 19.70	2 0.99	1 0.49%	—	—
Smoothness of fruit	203	23 11.33	89 43.84	80 39.41	7 3.45	4 1.97%	—	—
Thinness of rind	205	132 64.39	56 27.32	10 4.88	6 2.93	1 0.49%	—	—
Thinness of segment wall	205	87 42.44	88 42.93	16 7.80	13 6.37	1 0.49%	—	—
Color of pulp	205	167 81.46	33 16.10	5 2.44	0 0	0 0%	—	—
Size of central column	205	9 4.39	49 23.90	136 66.36	7 3.41	4 1.95%	—	—
Quantity of pith	205	2 0.98	78 38.05	121 59.02	4 1.95	0 0%	—	—
Quality of pulp	205	52 25.37	83 40.00	64 31.22	6 2.93	1 0.49%	—	—
Degree of wrinkles on surface	203	1 0.49	44 21.67	124 61.08	34 16.75%	—	—	—

stands in the North plot No. 4, northern corner, road-side, 1st tree on the west, planted 4.04 m. away from other trees. It is a tree about 16 years old, has an E-W spread of 2.47 m., N-S spread of 2.03 m., and height of 1.74 m. It is trained to have many branches and the shoot is upright. Leaves many, more or less hanging, both ends broad. Soil condition and fertilizers as was described under Lot No. 21. The plant was purchased from Inosuke SHIRAKUSA, the first booster of the Owari variety. The measurements of the total crop of the tree are given in Table 67.\*

The fruit is very much larger than that of the previous lot, the still more flat in association with a larger degree of wrinkles. Moreover, this has an extremely deep apical depression and very conspicuous areola of "R" degree, i. e., composed of multiple rings of fovea. The base is also deeply depressed. The area enclosed by the areola is very naked, devoid of oil cell dots. Rind is not very thin, but segment wall is extremely thin, with the exception of a few off-type fruits which have a thickened wall. Quantity of pith is normal, color of pulp not very intense, and of moderately good quality. The comparison shows the clear difference of the variety, and it can be concluded that the wrinkle variation occurs both in the Ikeda and the Owari varieties.

The wrinkled Satsumas seem also prevalent among Owari nursery plants sent directly from Owari Province. In the orchard of Sukesaku TAKANO, at Tarumidzu in Kagoshima Prefecture, many individual plants showed such wrinkled fruits, and these trees had been originally shipped by the Nippon Engei Kabushiki Kwaisha of Chiyoda-mura, Nakajima-gun, Owari Province. Similar wrinkled Owari fruits were also observed at the Ninomiya sub-station of the Kanagawa Agricultural Experiment Station. As SHAMEL<sup>(115)</sup> points out, the wrinkled fruits of flat outline appear as a bud variation in the Washington Navel orange, and this character is rather uncertain, being associated with other variations like small fruiting and rough fruiting. It is, however, not a physiological variation, but seems to be a variation emphasized by physiological condi-

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\* PL. XVI, Fig. 1.

TABLE 67.

MEASUREMENT OF WRINKLED OWARI SATSUMA FRUITS FROM HÔKWAEN  
ORCHARD NEAR KAGOSHIMA. LOT NO. 19 OF 1919.  
TOTAL NUMBER OF FRUITS, 507.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.89 cm.	4.07 cm.	1.56	66.84 gm.	—	10.83	2.66 mm.	13.92 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	507	—	—	—	—	—	29	% 5.72
Sinuate based fruits	507	—	—	—	—	—	20	3.94
Semi-sinuate based fruits	507	—	—	—	—	—	364	71.80
Areolated fruits	506	—	—	—	—	—	504	99.60
Frs. with undeveloped calyx lobes	431	—	—	—	—	—	74	17.17
Frs. with long narrow calyx lobes	431	—	—	—	—	—	16	3.71
Fruits containing seeds	507	—	—	—	—	—	52	10.26
Apical depression	505	411 81.39	24 4.75	70 13.86	0 0%	—	—	—
Apical dots	506	302 59.68	176 34.78	28 5.53%	—	—	—	—
Flatness of fruit	506	252 49.80	220 43.48	29 5.73	4 0.79	1 0.20%	—	—
Smoothness of fruit	507	10 1.97	212 41.81	110 21.70	175 34.52%		—	—
Thinness of rind	507	289 57.00	121 23.87	73 14.40	20 3.94	4 0.79%	—	—
Thinness of segment wall	504	464 92.06	33 6.55	0 0	6 1.19	1 0.20%	—	—
Color of pulp	495	223 45.05	243 49.09	29 5.86	0 0	0 0%	—	—
Size of central column	507	37 7.30	215 42.41	249 49.11	5 0.99	1 0.20%	—	—
Quantity of pith	506	0 0	14 2.77	418 82.61	71 14.03	3 0.59%	—	—
Quality of pulp	505	182 36.04	234 46.34	89 17.62	0 0	0 0%	—	—
Degree of wrinkles on surface	505	28 5.54	325 64.36	141 27.92	11 2.18%	—	—	—



tions, when the plant has the definite element that produces wrinkles on the fruit. Such plant may not necessarily show this character when the condition of the tree is quite normal. Wrinkling is not corrugation. Corrugated Satsumas are sometimes cultivated in gardens under the name "Shima Unshû", for ornamental purposes.

### *Variegated Satsuma*

The second common variation frequently occurring in the Ikeda variety is variegation, which sometimes occurs also in the Owari. A top-worked variegated Satsuma of local origin was found in an orchard of Den YABUNE, of Tadono-mura, Arita-gun, Wakayama-ken. (PL. XLVIII, Fig. 5.) The stock of this plant is a fairly large-sized Kinokuni mandarin, having several large branches, one of which is used for top-working. The scion part is a single limb, divided into two branches at about 30 cm. from the bottom. There are approximately 20 branches on the upper limb 1.91 m. long, all being variegated except two small independent shoots and a larger branch with two shoots having pure green leaves on it. This variegated Satsuma bore no fruit in 1920, but there were two smaller individuals which had been propagated from the larger one, bearing fruit. These two trees, ciphered A and B, are located at the Arita Citrus sub-station of the Wakayama Prefectural Agricultural Experiment Station, Inokuchi, Tadono-mura. The descriptions of these trees are given as follows:

Lot No. 57 and 58 of 1920. Variegated Satsuma A at the Miyayama orchard of the station, on a steep slope dipping to the south. It is located in the lowermost plot of the variety test orchard (2nd terrace from the ridge), the 3rd tree at the western end, planted at the distance of 3.46 m. from the others. It is about 15 years since it was set, has an E-W spread of 1.42 m., N-S spread of 1.16 m., and height of 1.12 m. It is a small tree, branches sparse and wide spreading, leaves small, boat-shaped, never hanging. Tree looks weakened by malnutrition. Soil is very poor, having a large quantity of gravel. This tree has two major branches and one of them is forked with widely spreading limbs. The

western limb has green leaves only, but the eastern limb has branchlets complicated by a mixture of both variegated and green leaves. The other major branch is generally variegated but it bears one green-leaved limb. The illustration (PL. XLVIII Fig. 6) shows the distribution of green leaves on the second branch mentioned above. Both normal and variegated fruits were collected separately, and the measurements are given in Tables 68\* and 69.\*\*

Lot No. 59 and 60 of 1920. Variegated Satsuma B tree at Arita Station. Location of the tree same as the foregoing lot, being the 4th tree. It is of the same age, having an E-W spread of 1.68 m., N-S spread of 1.45 m., and height of 1.75 m. It is a little larger tree than A and is not so weakened, is rather densely branched, side branches drooping. Leaves small but more or less larger than those of A, and more dense, boat-shaped. One large branch bears a mixed crop and leaves, while the other part bears normal fruits. The measurements of normal and variegated fruits are given in Tables 70\*\*\* and 71\*\*\*\*, respectively.

There is another tree of the same age in Mr. YABUNE's orchard, which bore no fruit in 1920. This plant has three major branches, one of which is green-leaved, while the rest have a mixture of variegated and normal shoots, as illustrated in the figure (PL. XLVIII Fig. 8). This plant has an E-W spread of 1.74 m., N-S spread of 2.11 m., and height of 1.91 m. (measurements in 1920). Branches of this tree are few, bending downward; leaves very much boat-shaped, not hanging, sparse, and rather weak-looking.

These mixtures of normal branches found on variegated individuals is unquestionably a case of vegetative reversion, if the variegated part is conceded as having arisen through bud variation. The occurrence of variegated limbs on a normal Satsuma plant by bud variation is described later.

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\* PL. XVI, Fig. 2.

\*\* PL. XVI, Fig. 3.

\*\*\* PL. XVI, Fig. 4.

\*\*\*\*PL. XVI, Fig. 5.

TABLE 68.

MEASUREMENT OF NORMAL IKEDA SATSUMA FRUITS FROM TREE 'A' AT  
ARITA SUBSTATION, WAKAYAMA PREFECTURE. LOT NO. 57 OF  
1920. TOTAL NUMBER OF FRUITS, 43 (NOS. 4089-4131).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.49 cm.	4.28 cm.	1.88	75.44 gm.	9.63 mm.	10.86	2.60 mm.	14.48 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	43	—	—	—	—	—	2	% 4.65
Sinuate based fruits	43	—	—	—	—	—	3	6.98
Semi-sinuate based fruits	43	—	—	—	—	—	1	2.33
Areolated fruits	43	—	—	—	—	—	25	58.14
Frs. with undeveloped calyx lobes	43	—	—	—	—	—	29	67.44
Frs. with long narrow calyx lobes	43	—	—	—	—	—	0	0
Fruits containing seeds	43	—	—	—	—	—	34	79.07
Apical depression	43	22 51.16	14 32.56	7 16.28	0 0%	—	—	—
Apical dots	43	0 0	18 41.86	25 58.14%	—	—	—	—
Flatness of fruit	43	0 0	5 11.63	32 74.42	6 13.95	0 0%	—	—
Smoothness of fruit	43	0 0	6 13.95	20 46.51	10 23.26	7 16.28%	—	—
Thinness of rind	43	27 62.79	12 27.91	4 9.30	0 0	0 0%	—	—
Thinness of segment wall	43	15 34.88	12 27.91	12 27.91	4 9.30	0 0%	—	—
Color of pulp	43	36 83.72	7 16.28	0 0	0 0	0 0%	—	—
Size of central column	43	7 16.28	11 25.58	25 58.14	0 0	0 0%	—	—
Quantity of pith	43	0 0	30 13.95	7 69.77	0 0	0 0%	—	—
Quality of pulp	43	4 9.30	21 48.84	17 39.53	1 2.33	0 0%	—	—

TABLE 69.

MEASUREMENT OF VARIEGATED IKEDA SATSUMA FRUITS FROM TREE 'A' AT  
ARITA SUBSTATION, WAKAYAMA PREFECTURE. LOT NO. 58 OF 1920.  
TOTAL NUMBER OF FRUITS, 18 (NOS. 4132-4144).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.23 cm.	3.93 cm.	1.39	60.46 gm.	8.85 mm.	11.15	2.50 mm.	14.42 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	13	—	—	—	—	—	3	23.08
Sinuate based fruits	13	—	—	—	—	—	9	69.23
Semi-sinuate based fruits	13	—	—	—	—	—	3	23.08
Areolated fruits	13	—	—	—	—	—	2	15.38
Frs. with undeveloped calyx lobes	13	—	—	—	—	—	9	69.23
Frs. with long narrow calyx lobes	13	—	—	—	—	—	0	0
Fruits containing seeds	13	—	—	—	—	—	10	76.02
Apical depression	13	1 7.69	6 46.15	5 38.46	1 7.69%	—	—	—
Apical dots	13	1 7.69	4 30.77	8 61.54%	—	—	—	—
Flatness of fruit	13	0 0	5 38.46	6 46.15	2 15.38	0 0%	—	—
Smoothness of fruit	13	4 30.77	3 23.08	6 46.15	0 0	0 0%	—	—
Thinness of rind	13	13 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	13	6 46.15	3 23.08	3 23.08	1 7.69	0 0%	—	—
Color of pulp	13	11 84.62	2 15.38	0 0	0 0	0 0%	—	—
Size of central column	13	2 15.38	4 30.77	7 53.85	0 0	0 0%	—	—
Quantity of pith	13	0 0	4 30.77	8 61.54	0 0	1 7.69%	—	—
Quality of pulp	13	2 15.38	5 38.46	6 46.15	0 0	0 0%	—	—

TABLE 70.

MEASUREMENT OF NORMAL IKEDA SATSUMA FRUITS FROM TREE 'B' AT  
ARITA SUBSTATION, WAKAYAMA PREFECTURE. LOT NO. 59 OF 1920.  
TOTAL NUMBER OF FRUITS, 59 (NOS. 4145-4203).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.78 cm.	4.32 cm.	1.39	78.84	9.41 mm.	11.32	2.88 mm.	17.10 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	59	—	—	—	—	—	12	20.34%
Sinuate based fruits	59	—	—	—	—	—	7	11.86
Semi-sinuate based fruits	59	—	—	—	—	—	11	18.64
Areolated fruits	59	—	—	—	—	—	23	38.98
Frs. with undeveloped calyx lobes	59	—	—	—	—	—	23	38.98
Frs. with long narrow calyx lobes	59	—	—	—	—	—	0	0
Fruits containing seeds	59	—	—	—	—	—	18	30.51
Apical depression	59	16 27.12	19 32.20	23 38.98	1 1.69%	—	—	—
Apical dots	59	3 5.08	31 52.54	25 42.37%	—	—	—	—
Flatness of fruit	59	3 5.08	24 40.68	25 42.37	7 11.86	0 0%	—	—
Smoothness of fruit	59	0 0	7 11.86	19 32.20	30 50.85	3 5.08%	—	—
Thinness of rind	59	23 38.98	24 40.68	10 16.95	2 3.39	0 0%	—	—
Thinness of segment wall	59	8 13.56	25 42.37	20 33.90	5 8.47	1 1.69%	—	—
Color of pulp	59	56 94.92	3 5.08	0 0	0 0	0 0%	—	—
Size of central column	59	17 28.81	16 27.12	26 44.07	0 0	0 0%	—	—
Quantity of pith	59	0 0	17 28.81	41 69.49	1 1.67	0 0%	—	—
Quality of pulp	55	16 29.09	24 43.64	14 25.45	1 1.82	0 0%	—	—

TABLE 71.

MEASUREMENT OF VARIEGATED IKEDA SATSUMA FRUITS FROM TREE 'B' AT  
ARITA SUBSTATION, WAKAYAMA PREFECTURE LOT NO. 60 OF 1920.  
TOTAL NUMBER OF FRUITS, 23 (NOS. 4204-4226).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.61 cm.	3.79 cm.	1.40	57.48 gm.	8.78 mm.	11.30	2.47 mm.	13.93 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	23	—	—	—	—	—	2	% 8.70
Sinuate based fruits	23	—	—	—	—	—	17	73.91
Semi-sinuate based fruits	23	—	—	—	—	—	2	8.70
Areolated fruits	23	—	—	—	—	—	2	8.70
Frs. with undeveloped calyx lobes	23	—	—	—	—	—	17	73.91
Frs. with long narrow calyx lobes	23	—	—	—	—	—	0	0
Fruits containing seeds	23	—	—	—	—	—	4	17.39
Apical depression	23	1 4.35	9 39.13	13 56.52	0 0%	—	—	—
Apical dots	23	1 4.35	8 34.78	14 60.87%	—	—	—	—
Flatness of fruit	23	3 13.04	12 52.17	5 21.74	3 13.04	0 0%	—	—
Smoothness of fruit	23	3 13.04	18 78.26	2 8.70	0 0	0 0%	—	—
Thinness of rind	23	13 56.52	7 30.43	2 8.70	1 4.35	0 0%	—	—
Thinness of segment wall	23	13 56.52	9 39.03	1 4.35	0 0	0 0%	—	—
Color of pulp	23	23 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	23	6 26.09	4 17.39	12 52.17	0 0	1 4.35%	—	—
Quantity of pith	23	0 0	2 8.70	19 82.61	2 8.70	0 0%	—	—
Quality of pulp	23	2 8.70	15 65.22	5 21.74	1 4.35	0 0%	—	—

The fruit of these lots agree with the general character of the Ikeda variety, and are rather large sized, and conspicuously truncate at both ends. The basal sinuation is sometimes very inconspicuous, due to the broad radial grooves existing around the calyx, associated with the variegation stripe running longitudinally above the surface. Calyx lobes are not well developed, areola moderately developed, navels rather few. The peculiar rectangular shape of the fruit is partly due to the pressure received by hard packing for transportation, and although the D/H index is rather large the fruit appears quite roundish, something identical to the shape of Ponkan. The rind texture is rough, rather puffy, convex dotted and pitted, more or less uneven and oily, many fruits being spoiled by sooty mould. Color is deep; in variegated fruits the stripes of yellow are very conspicuous, and some fruit is entirely yellow without any deep colored stripes. In the cross-section, the rind is more or less baggy, rind rather uniform in thickness, oil cells closely gathered, generally much elongated, pith layer quite white. Segment very irregular, segment wall parallel to the outline, and rounded at its outer corner, rounded or pointed at the inner end, thick and white in seedy fruits, pith also fairly abundant. Pulp generally soft and melting, fair in quality, very deep-colored, vesicle wall thin, netted or rather elongated.

The fact that the variegated limb occurs in the Owari Satsuma orange was definitely noticed at Nebukawa, in Kanagawa Prefecture. The tree was a well fertilized, vigorous Owari Satsuma, about 15 years of age, having an E-W spread of 2.88 m., N-S spread of 2.88 m., and height of 2.62 m. The branches are well spreading normally without stray limbs of irregular growth, shoots dense and strong, and leaves large and typical of Owari. An eastern branch is variegated, but no fruit is borne on it. The soil is black volcanic loam without pebbles, mulched with straw. Similar variation was also noticed in Mizomoto's orchard in Ikiriki village, upon the north-eastern individual of Lot No. 8 tree of 1919. A single variegated fruit borne on this branch was measured. It has a girth of 20.5 cm., height 4.6 cm., D/H index 1.42, weight 101 gm., calyx 9 mm. in diam., with broad depression at the apex, areolate, open naveled, and calyx lobes not well developed.

*Willow-leaf Ikeda Satsumas*

Another common variation of the Ikeda variety is the creation of willow-leaf and globose fruit associated together. The first case which the author observed was a dual individual, partly normal and partly willow-leaf, found in Monzaburô GORYÔDA's orchard at Adzuchi, Ôchô-mura, Toyoda-gun, Hiroshima-ken (PL. XLVIII, Fig. 9). Details of the tree are as follows :

Lot No. 66 of 1920. GORYÔDA's willow-leaf Ikeda plant in Ôchô village, amongst a solid orchard of Ikeda variety of ages between 22 and 23 years which is surrounded by a small planting of Washington Navel and lemon. It is on a slow slope facing the north, and open to the east, slightly northward. Location of the tree is on the 3rd terrace from the flat land, 3rd row and the 3rd tree, planted at the distance of 3.45 m. The size of the tree is, E-W spread 5.20 m., N-S spread 5.20 m., and height 2.9 m. Unpruned tree on large trifoliate root, the girth of which measures 74 cm. It divides immediately above the union, appearing to have two independent scions put on to a single stock. Trunk at the western side, with a girth of 39 cm., bears normal leaves, while that on the eastern, with a girth of 38 cm., is willow-leaved. The latter has three large branches divided at 48 cm. from the ground, spreading toward the east, the west, and the south, respectively. All branches are drooping at the ends, the habit of growth of both parts being practically similar. The leaves of each part are greatly different. The willow-leaf part has leaves extremely narrow in outline, with an irregular marginal line, very narrowed apex, extremely narrowed base, and with petiole wings much reduced in width, the total lamina having a somewhat contorted appearance. The soil is gravel loam containing plenty of angular gravel ; mulched with straw. The measurements of fruits of both parts are given in Table 72\* and Table 73.\*\*

The fruit of the normal part is rather small, depressed globose, rather flat, coarsely pitted, deep-colored, apex shallowly concave, often sinuous

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\* PL. XVI, Fig. 6.

\*\* PL. XVII, Fig. 1.



TABLE 72.

MEASUREMENT OF FRUITS FROM NORMAL PART OF GORYÔDA'S IKEDA  
SATSUMA AT ÔCHÔ, HIROSHIMA PREFECTURE. LOT NO. 54 OF 1920.  
TOTAL NUMBER OF FRUITS, 95 (NOS. 4436-4530).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.69 cm.	4.00 cm.	1.41	64.46 gm.	9.51 mm.	9.94	2.77 mm.	11.12 mm.

No. fo fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	95	—	—	—	—	—	12	12.64%
Sinuate based fruits	95	—	—	—	—	—	55	57.89
Semi-sinuate based fruits	95	—	—	—	—	—	41	43.16
Areolated fruits	95	—	—	—	—	—	45	47.37
Frs. with undeveloped calyx lobes	95	—	—	—	—	—	37	38.95
Frs. with long narrow calyx lobes	95	—	—	—	—	—	0	0
Fruits containing seeds	95	—	—	—	—	—	0	0
Apical depression	95	8 8.42	40 42.11	43 45.26	4 4.21%	—	—	—
Apical dots	95	1 1.05	26 27.37	68 71.58%	—	—	—	—
Flatness of fruit	95	4 4.31	47 49.47	44 46.32	0 0	0 0%	—	—
Smoothness of fruit	95	0 0	0 0	93 97.89	2 2.11	0 0%	—	—
Thinness of rind	95	24 25.26	47 49.47	24 25.26	0 0	0 0%	—	—
Thinness of segment wall	95	92 96.84	3 3.16	0 0	0 0	0 0%	—	—
Color of pulp	95	89 93.88	6 6.32	0 0	0 0	0 0%	—	—
Size of central column	95	0 0	2 2.11	42 44.21	45 47.37	6 6.32%	—	—
Quantity of pith	95	0 0	0 0	49 51.58	30 31.58	16 16.84%	—	—
Quality of pulp	95	26 27.96	30 32.26	35 37.63	3 2.15	0 0%	—	—

TABLE 73.

MEASUREMENT OF FRUITS FROM WILLOW-LEAF PART OF GORYÔDA'S  
IKEDA SATSUMA AT ÔCHÔ, HIROSHIMA PREFECTURE. LOT NO. 66 OF  
1920. TOTAL NUMBER OF FRUITS, 94 (NOS. 4342-4435).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.36 cm.	4.04 cm,	1.29	53.27 gm.	8.25 mm.	10.78	3.03 mm.	10.70 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	94	—	—	—	—	—	4	% 4.26
Sinuate based fruits	94	—	—	—	—	—	27	28.72
Semi-sinuate based fruits	94	—	—	—	—	—	41	43.62
Areolated fruits	94	—	—	—	—	—	16	17.02
Frs. with undeveloped calyx lobes	92	—	—	—	—	—	69	75.00
Frs. with long narrow calyx lobes	92	—	—	—	—	—	3	3.26
Fruits containing seeds	94	—	—	—	—	—	0	0
Apical depression	94	3 3.19	32 34.04	46 48.94	13 13.83	—	—	—
Apical dots	93	2 2.15	39 41.94	52 55.91%	—	—	—	—
Flatness of fruit	94	0 0	13 13.83	29 30.85	22 23.41	30 31.91%	—	—
Smoothness of fruit	94	0 0	20 21.28	68 72.34	6 6.38	0 0%	—	—
Thinness of rind	94	9 9.57	30 31.92	25 26.60	16 17.02	14 14.89%	—	—
Thinness of segment wall	94	59 62.77	33 35.10	2 2.13	0 0	0 0%	—	—
Color of pulp	94	39 41.49	35 37.23	19 20.21	1 1.06	0 0%	—	—
Size of central column	94	1 1.06	2 2.13	41 43.62	29 30.85	21 22.34%	—	—
Quantity of pith	94	0 0	0 0	50 53.19	35 37.23	9 9.57%	—	—
Quality of pulp	92	1 1.09	33 35.86	51 55.44	6 6.52	1 1.09%	—	—

at the styler point, navel not developed and areola not marked. Basal depression sinuate or small crater-like, radial grooves not conspicuous. Calyx rather large, deep green, body large, lobes not well developed, disk concealed, strongly adpressing the peel. In cross-section, rind is thin or medium-thin, segment wall thin, central column medium or medium-small, and pith medium or medium-little in amount. Pulp deep-colored, meaty, rather fine-grained but parallel, not anastomosing. Taste medium or medium-good, not very good. Outer end of the segment wall is parallel with the outline, inner end only pointed or blunt-tipped, oil cells much elongated, close in one row. Rind is sometimes free from the segment.

The fruit of the willow part is small, conspicuously tall, more or less truncate, lightly pitted, deep-colored, a few puffy fruits being flat and smoother, outline regular, generally compact and durable. Apex moderately depressed, areola almost inconspicuous, very broad when present, navel only rarely present. Base conspicuously truncate, stem-end sinuous, without groove. Calyx rather small, lobes irregular, body rather large, disk often disclosed with surrounding small flattened area. In cross-section, the rind is very thick, segment wall rather thin, parallel on the outer end, pointed at the inner end, free from each other, being detached; central column small, sometimes irregular in shape, amount of pith small. Pulp deep-colored, rather poor in quality, number of vesicles conspicuously few, stretched in length. In comparison with the fruit of the normal part, this has a conspicuously more round, truncate outline, sinuous base and thick rind.

A similar willow-leaf individual of the Ikeda variety was found in the orchard of Itarō YAKUSHJI, of Hagiwara, Ōkawachi, Tachima-mura, Kitauwa-gun, Ehime-ken in Shikoku Island. This plant, which turned out to be the willow-leaf after arrival, was purchased from Ōsaka, presumably propagated in the Ikeda district. The description of this plant is as follows:

Lot No. 67 of 1920. YAKUSHJI's willow-leaf individual in Tachima village. Standing on a steep hill facing toward the east, about the middle of the eighth terrace from the bottom, planted 6.34 m. away from others. It is an erect tree, having an E-W spread of 2.03 m., N-S spread 2.03 m.,

and height of 2.03 m.; the girth above the union is 23 cm., that of the trifoliate root crown 43 cm. Branches more or less upright, not drooping, foliage dense, straight, and erect, less hanging, lamina narrow and tapering, deep colored. Soil graveled loam, no mulch, fertilizer soy bean cake, wood ash and bone dust. The measurements of the fruit are given in Table 74.\*

The fruit is medium-sized, ranging from medium-large to very small, shape round, conspicuously elongated, being high or medium-high, shoulder high, truncate in many cases, outline regular. Apex rounded or slightly depressed, navel closed, dots very much reduced in number around the styler point, base rather strongly depressed, more or less sinuous or with broad naked area around the calyx, disk not conspicuously developed. Calyx rather small, lobes more or less irregular, body rather well developed, light-colored. Rind surface even or lightly pitted, fully mature but some fruit light-colored, rarely scabby. In cross-section, rind extremely thick with a large quantity of white rag, oil cells large, globose, apart from each other, never crowded as in GORYÔDA's willow-leaf individual. Segments few, large-sized, segment wall rather thick, outer end parallel or wavy, corner not rounded, angular in many fruits, inner end is often associated with others in group. Central column small, pith hard and adherent to the end of segment wall. Pulp very meaty, tenacious, more or less light colored, vesicles large, few in number, elongated, wall rather thick, very inferior in quality.

The third case of willow-leaf Ikeda is an another dual plant found in an orchard of Shigeru SUGIYAMA of Enokidaira, Iwa-mura, Ashigara-himo-gun, Kanagawa-ken. Its description is as follows:

Lot No. 65 of 1920. SUGIYAMA's willow-leaf Ikeda in Iwa-mura. Standing in a terrace orchard inclined toward the north-east, each terrace having the breadth of 2.62 m. The plant has a common root of trifoliate orange with two buds inserted on the stock, one of which developed into the willow-leaf, the other into a normal Satsuma. It has an E-W spread of 4.33 m., N-S spread of 2.62 m., and height of 3.46 m., is of upright

\* PL. XVII, Fig. 2.

TABLE 74.

MEASUREMENT OF WILLOW-LEAF IKEDA FRUITS FROM YAKUSHIJI'S  
ORCHARD AT TACHIMA, EHIME PREFECTURE. LOT NO. 67 OF  
1920. TOTAL NUMBER OF FRUITS, 40 (NOS. 4302-4341).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.32 cm.	4.62 cm.	1.26	77.50 gm.	9.05 mm.	10.00	3.58 mm.	12.63 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	39	—	—	—	—	—	1	2.56%
Sinuate based fruits	39	—	—	—	—	—	13	33.33
Semi-sinuate based fruits	39	—	—	—	—	—	8	20.51
Areolated fruits	39	—	—	—	—	—	10	25.64
Frs. with undeveloped calyx lobes	37	—	—	—	—	—	15	40.54
Frs. with long narrow calyx lobes	37	—	—	—	—	—	1	2.70
Fruits containing seeds	40	—	—	—	—	—	0	0
Apical depression	39	0 0	5 12.82	20 51.28	14 35.90%	—	—	—
Apical dots	39	12 30.77	18 48.72	8 20.51%	—	—	—	—
Flatness of fruit	39	0 0	1 2.56	5 12.82	14 35.90	19 48.72%	—	—
Smoothness of fruit	39	0 0	14 35.90	16 41.03	3 7.69	6 15.38%	—	—
Thinness of rind	39	0 0	0 0	12 30.77	14 35.90	13 33.33%	—	—
Thinness of segment wall	39	2 5.13	5 12.82	31 79.49	1 2.56	0 0%	—	—
Color of pulp	39	8 20.51	19 48.72	12 30.77	0 0	0 0%	—	—
Size of central column	39	0 0	0 0	22 56.41	15 38.46	2 5.13%	—	—
Quantity of pith	39	0 0	12 30.77	27 69.23	0 0	0 0%	—	—
Quality of pulp	39	0 0	0 0	13 33.33	19 48.72	7 17.95%	—	—

habit, the western willow trunk has a girth of 35 cm. above the union. The bud stick came from Kishô, Nishiura-mura, Takata-gun of the same prefecture (Idzu Peninsula). Soil brown, of volcanic origin, with hard reddish-brown subsoil. Mixed commercial fertilizers are used ; no mulch. Only 10 fruits were collected from the willow part, as the picking season was over, and no fruit was left on the normal part of the tree. The measurements of the fruit are given in Table 75.\*

The fruit is round with sinuous base, round apex with oil cell dots, less developed areola and navel, and fairly abundant individual fruits with undeveloped calyx lobes. Surface is medium-smooth. In cross-section, rind is moderately thick, wall also moderately thick, central column rather medium-small in size, quite abundant pith. Pulp deep-colored, poor in quality.

The origin of the willow-leaf Satsuma was not definitely known, but a plant partly normal and partly willow-leaf (not a two-budded tree) was found in the orchard of Sôsuke NARIKAWA, of Yamada-mura, Arita-gun, Wakayama-ken (PL. XLVIII. Fig. 10.). This plant, about 25 years old, is located in a very much crowded plot on the top of a hill ridge, and has a trunk divided into three major branches about 29 cm. above the union. One branch exclusively normal, second is normal at the bottom but entirely willow-leaved at the end, and the third is normal, with the exception of a tip of a small curved shoot nearest the dividing portion. This shows that the plant has willow traits in it, shows this character at certain points subject to the conditions which produce variation. The plant was purchased as a nursery plant. There is another tree entirely willow-leaved but it is planted close together with a normal tree and looks like a single plant (PL. XLVIII, Fig. 11). This condition shows plainly that the owner bought very poor nursery plants, propagated from a certain orchard where such a willow-leaved sport was present, and which supplied bud sticks of the same character. The peculiar bud-variation look of the plant given here, is because the willow-leaf character is something like "hyperchimera" in nature, the willow

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\* PL. XVII, Fig. 3.

TABLE 75.

MEASUREMENT OF FRUITS FROM SUGIYAMA'S WILLOW-LEAF SATSUMA  
TREE AT IWA-MURA, KANAGAWA PREFECTURE. LOT NO. 65 OF  
1920. TOTAL NUMBER OF FRUITS, 10 (NOS. 2065-2074).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.89 cm.	4.39 cm.	1.30	62.80 gm.	9.40 mm.	11.00	3.75 mm.	11.70 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	10	—	—	—	—	—	2	% 20.00
Sinuate based fruits	10	—	—	—	—	—	6	60.00
Semi-sinuate based fruits	10	—	—	—	—	—	2	20.00
Areolated fruit	10	—	—	—	—	—	2	20.00
Frs. with undeveloped calyx lobes	10	—	—	—	—	—	4	40.00
Frs. with long narrow calyx lobes	10	—	—	—	—	—	0	0
Fruits containing seeds	10	—	—	—	—	—	0	0
Apical depression	10	0 0	0 0	5 50.00	5 50.00%	—	—	—
Apical dots	10	0 0	3 30.00	7 70.00%	—	—	—	—
Flatness of fruit	10	0 0	3 30.00	3 30.00	2 20.00	2 20.00%	—	—
Smoothness of fruit	10	1 10.00	7 70.00	0 0	0 0	2 20.00%	—	—
Thinness of rind	10	0 0	3 30.00	6 60.00	0 0	1 10.00%	—	—
Thinness of segment wall	10	0 0	2 20.00	4 40.00	4 40.00	0 0%	—	—
Color of pulp	10	9 90.00	1 10.00	0 0	0 0	0 0%	—	—
Size of central column	10	0 0	0 0	5 50.00	5 50.00	0 0%	—	—
Quantity of pith	10	0 0	7 70.00	3 30.00	0 0	0 0%	—	—
Quality of pulp	10	0 0	1 10.00	4 40.00	4 40.00	1 10.00%	—	—

character, being concealed in the tissue, and is disclosed at certain points where the normal character is weakened. It, therefore, shows a different degree of willowness at different times of observation, or through different treatment given to the tree. The tree in question was very heavily pruned about three years before the time of observation, and according to a remark by a member of the staff of the Arita Substation, the aspect of willowness has been much changed since that time. Similar observation was also made in Alabama in the United States, which shows that the variability is extremely unstable, sometimes producing a greater amount of willow leaves, and sometimes such leaves are reduced almost to nothing. NARIKAWA's plant has an E-W spread of 3.46 m., N-S spread of 3.46 m., and height of 2.67 m. Soil condition is rather good, the soil being pebbled loam. The surface is mulched, and the standard fertilizers of the substation ratio are applied, containing 14 kg. of nitrogen. Measurements of fruits picked from the normal and the willow part of the tree are given in Table 76\* and Table 77\*\*, respectively.

Fruits from the normal part of the tree are medium-large, shape conspicuously rounded and truncate, apex rather deeply depressed but areola rather inconspicuous, navels also few. Base sinuous or deeply depressed, less grooved. Calyx medium-sized, body rather large, lobes more or less irregular, light colored, disk not enlarged. Texture of skin is compact, surface deep-colored, smooth or pitted, but not rough, greasy, slightly affected by sooty mould. Tight-skinned, oil cell dots large and often very prominent. In cross-section, rind and segment wall medium-thin, outer end of the wall rather rounded, corner also rounded, inner end pointed or only slightly rounded, central column medium or slightly larger, pith hard, often pulling the segment end together in groups. Pulp deep-colored and bitter in taste, only fair in quality, vesicles meaty, rather coarse, more or less stretched. Oil cells of the rind large and arranged closely in one row.

Fruits of the willow part are slightly smaller, shape very much elongated and very often with pointed base. Apex rather deeply

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\* PL. XVII, Fig. 4.

\*\* PL. XVII, Fig. 5.



TABLE 76.

MEASUREMENT OF NOMAL FRUITS FROM NARIKAWA'S WILLOW-LEAF  
IKEDA PLANT AT MIYABARA-MURA, WAKAYAMA PREFECTURE.

LOT NO. 69. TOTAL NUMBER OF FRUITS, 33 (NOS. 4227-4259).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.76 cm.	4.74 cm.	1.39	101.73gm.	10.34 mm.	10.70	3.09 mm.	16.35 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	33	—	—	—	—	—	6	18.18
Sinuate based fruits	33	—	—	—	—	—	19	57.58
Semi-sinuate based fruits	33	—	—	—	—	—	14	42.42
Areolated fruits	33	—	—	—	—	—	22	66.67
Frs. with undeveloped calyx lobes	33	—	—	—	—	—	10	30.30
Frs. with long narrow calyx lobes	33	—	—	—	—	—	5	15.15
Fruits containing seeds	33	—	—	—	—	—	0	0
Apical depression	33	9 27.27	24 72.73	0 0	0 0%	—	—	—
Apical dots	33	2 6.06	21 63.63	10 40.40%	—	—	—	—
Flatness of fruit	33	0 0	13 39.39	18 54.54	2 6.06	0 0%	—	—
Smoothness of fruit	33	0 0	12 36.36	15 45.45	6 18.18	0 0%	—	—
Thinness of rind	33	7 21.21	12 36.36	13 39.39	1 3.03	0 0%	—	—
Thinness of segment wall	33	7 21.21	17 51.51	8 24.24	1 3.03	0 0%	—	—
Color of pulp	33	10 30.30	18 54.54	5 15.15	0 0	0 0%	—	—
Size of central column	33	1 3.03	8 24.24	22 66.67	2 6.06	0 0%	—	—
Quantity of pith	33	0 0	2 6.06	27 81.81	4 12.12	0 0%	—	—
Quality of pulp	31	2 6.45	15 48.38	11 35.48	3 9.68	0 0%	—	—

TABLE 77.

MEASUREMENT OF WILLOW-LEAF SATSUMA FRUITS FROM NARIKAWA'S  
VARIABLE IKEDA TREE AT MIYABARA-MURA, WAKAYAMA-KEN.

LOT NO. 68. TOTAL NUMBER OF FRUITS, 42 (NOS. 4260-4301).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.11 cm.	5.09 cm.	1.20	87.36 gm.	9.24 mm.	10.71	3.86 mm.	13.04 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	42	—	—	—	—	—	0	% 0
Sinuate based fruits	42	—	—	—	—	—	11	26.19
Semi-sinuate based fruits	42	—	—	—	—	—	9	21.43
Arcolated fruits	42	—	—	—	—	—	13	30.95
Frs. with undeveloped calyx lobes	42	—	—	—	—	—	19	45.24
Frs. with long narrow calyx lobes	42	—	—	—	—	—	1	2.38
Fruits containing seeds	42	—	—	—	—	—	1	2.38
Apical depression	42	7 16.67	20 47.62	14 33.33	1 2.38%	—	—	—
Apical dots	42	10 23.81	23 54.76	9 21.43%	—	—	—	—
Flatness of fruit	42	0 0	0 0	3 7.14	16 38.10	23 54.76%	—	—
Smoothness of fruit	42	0 0	1 2.38	25 59.52	16 38.10	0 0%	—	—
Thinness of rind	42	0 0	0 0	7 16.67	10 23.81	23 59.52%	—	—
Thinness of segment wall	42	0 0	13 30.95	23 66.67	1 2.38	0 0%	—	—
Color of pulp	42	20 47.62	20 47.62	2 4.76	0 0	0 0%	—	—
Size of central column	42	0 0	0 0	20 47.62	17 40.48	5 11.90%	—	—
Quantity of pith	42	0 0	1 2.38	29 69.05	12 28.57	0 0%	—	—
Quality of pulp	42	2 4.76	18 42.86	18 42.86	4 9.52	0 0%	—	—

depressed, areola not conspicuous, broad, navel insignificant, sometimes sinuous at the styler point. Base sinuous or deeply depressed, sharply pressed in, not grooved. Calyx deep-colored, body well developed, lobes rather irregular, thin, disk not enlarged. Surface oily, lightly or deeply pitted, tight, bright colored, oil cell dots not sparse. In cross-section, rind thick, oil cells very large and fairly parallel with the outline, corner more or less rounded, inner end rather pointed. Central column rather small, pith hard. Pulp very deep-colored, hard, bitterish and only fair in quality, vesicle very coarse, meaty, long, stretched. General characters are identical with fruits of YAKUSHIJI's willow-leaf Ikeda, except the small amount of pith and the bitterness of pulp. At any rate, these willow-leaf Satsuma fruits are inferior in quality to the common Ikeda fruits, and have no special commercial value. In later years, the author has met several other cases of willow-leaf individuals, some of which were only partly so, appearing to be of a chimeric nature. Fruit studies were also conducted, but the data is not presented here in order to avoid repetition of similar examples. It is interesting that in no case a willow-leaf individual belongs to the Owari variety. A remarkable bifacial tree of Yokichi YAMAMISAKA's, at Ishigawara, Aoyagi-mura, Kasuya-gun, Fukuoka-ken, was received by KUBO's nurseries of Ikeda under the name of "Kairyô Unshû" or "Owari Satsuma," but the normal fruit of the plant proved to be Ikeda.

## FURTHER DATA ON THE VARIATION OF THE IKEDA SATSUMA

### *Unproductive Ikeda Satsumas*

In 1919, very peculiar plants with extremely small leaves were found mixed in the Satsuma orchard at Hôkwaen, near Kagoshima. These plants were said by the owner of the orchard to be unproductive individuals. These individuals, about 10 in all, were bought with other Owari Satsumas from the SHIRAKUSA nurseries in Idzumi Province. Their general character agrees with that of Ikeda, but a critical study was

carried on, a representative plant being used. The description of this plant is as follows :

Lot No. 20 of 1919. Ikeda Satsuma at Hôkwaen orchard, Yashirô SETOGUCHI, proprietor, in Yoshino-mura, near Kagoshima city. The tree stands in North plot No. 3, being the third tree from the west along the road, on nearly level land : tree rows E-W 3.46 m., N-S 4.33 m. It is an unpruned tree, having an E-W spread of 2.88 m., N-S spread of 3.31 m., and height of 2.03 m., and it is about 16 years after planting. The branches are spreading and then drooping, shoots many, small, weak ; leaves very small, many are upright and not hanging, ends pointed, thick and boat-shaped. Condition of the soil and fertilization as given in describing Lot No. 21. The measurements of fruits from the whole tree are given in Table 78.\*

The character of fruit is exactly similar to that of the Ikeda fruits used for comparison (lots B to G of 1919). The shape is depressed globose, not conical, less depressed at the apex and sinuate at the stem-end and the size is extremely small, rind with moderately large and dense oil cell dots partly convex and partly pitted. The calyx is small with poorly developed calyx lobes. In cross-section, rind is more or less thin, and segment wall also fairly thin. Pulp is very deep-colored, its quality is good, texture is rather hard, not melting, vesicles being fine, elongated, parallel, not gathered at the middle line. Central column medium-sized, pith also medium in quantity.

The general outlook of these Ikeda plants, mixed in an Owari plantation, shows that they are not so productive as common Ikeda, but in all respects their characters are thoroughly in agreement with the Ikeda. These individuals, having unquestionable Ikeda parentage, were probably propagated unknowingly from an unproductive individual grown in Idzumi region, where a great majority of the orchard plants are Ikeda.

The measurements of materials used for comparison are given in Table 79, and the source of materials is as follows :

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\* PL. XVIII, Fig. 1.

TABLE 78.

MEASUREMENT OF IKEDA SATSUMA FRUITS (UNPRODUCTIVE) FROM A  
TREE AT HÔKWAEN ORCHARD, NEAR KAGOSHIMA. LOT NO. 20 OF  
1919. TOTAL NUMBER OF FRUITS, 270.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
15.64 cm.	3.62 cm.	1.88	46.71 gm.	—	10.81	2.13 mm.	10.23 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	270	—	—	—	—	—	48	17.78%
Sinuate based fruits	270	—	—	—	—	—	137	50.74
Semi-sinuate based fruits	270	—	—	—	—	—	89	32.96
Areolated fruits	270	—	—	—	—	—	100	37.04
Frs. with undeveloped calyx lobes	183	—	—	—	—	—	138	75.41
Frs. with long narrow calyx lobes	183	—	—	—	—	—	3	1.64
Fruits containing seeds	270	—	—	—	—	—	104	38.52
Apical depression	269	26 9.67	83 30.86	108 40.15	52 19.33%	—	—	—
Apical dots	270	17 6.30	72 26.67	181 67.04%	—	—	—	—
Flatness of fruit	270	15 5.56	205 75.93	46 17.04	4 1.48	0 0%	—	—
Smoothness of fruit	270	6 2.22	162 60.00	90 33.33	5 1.85	7 2.59%	—	—
Thinness of rind	267	185 68.91	59 22.10	22 8.24	2 0.75	0 0%	—	—
Thinness of segment wall	267	234 87.64	25 9.36	7 2.62	1 0.37	0 0%	—	—
Color of pulp	268	241 89.93	27 10.07	0 0	0 0	0 0%	—	—
Size of central column	266	0 0	28 10.53	204 76.69	32 12.03	2 0.75%	—	—
Quantity of pith	266	0 0	45 16.92	187 70.30	32 12.03	2 0.75%	—	—
Quality of pulp	251	193 76.89	51 20.32	7 2.79	0 0	0 0%	—	—

**TABLE 79.**  
**MEASUREMENT OF IKEDA SATSUMA FRUITS FROM VARIOUS SOURCES**  
**(POPULATION) USED FOR THE PURPOSE OF COMPARISON IN**  
**THE YEAR 1919. LOTS B-G.**

	B	C	D	E	F	G
Girth in cm.	15.69	11.23	16.06	19.03	18.01	16.83
Height in cm.	3.96	3.29	4.04	5.06	4.17	4.00
D/H Index	1.26	1.09	1.27	1.20	1.32	1.34
Weight in gm.	49.50	32.50	55.80	85.40	69.59	53.64
Number of segments	9.87	10.00	9.40	11.00	10.18	10.45
Thickness of rind in mm.	2.56	2.15	2.20	3.65	3.22	2.52
Size of central column in mm.	10.00	7.60	9.70	11.20	12.74	10.86
Naveled fruit (percentage)	0 0	0 0	0 0	0 0	4 23.53	3 27.27
Sinuate based fruit (percentage)	6 75.00	5 50.00	5 100.00	4 80.00	9 52.94	9 81.81
Semi-sinuate based fruit (percentage)	2 25.00	2 20.00	0 0	1 20.00	0 0	1 10.00
Areolated fruit (percentage)	0 0	3 30.00	3 60.00	2 40.00	4 23.53	4 36.36
Fruit with undeveloped calyx lobes (percentage)	5 62.50	5 50.00	2 40.00	?	8 53.33	7 63.63
Fruit containing seeds (percentage)	0 0	0 0	0 0	3 60.00	2 18.18	0 0

Lot B. Ikeda fruits collected at the orchard of Saburobei MORI, Yamataekami-mura, Sennan-gun, Ôsaka-fu. 8 fruits.

Noticeable characters: Pulp vesicles stretched in length, meaty, segment wall thick, stiff; oil cells of the rind homogeneous.

Lot C. Ikeda fruits purchased at the Ôsaka market under the name "Yukô". 10 fruits.

Noticeable characters: Tall shape, deep-colored rind, small calyx, small central column, and meaty hard pulp of good quality.

Lot D. The same. 5 fruits.

Noticeable characters: Rind smooth or harshed, pulp vesicles coarse, meaty, color rather light.

Lot E. The same. 5 fruits.

Noticeable characters: Rind rough, one fruit late bloom, warty. Pulp vesicles elongated, large, hard, more or less light-colored. Segment wall thick.

Lot F. Ikeda fruits from the Wakayama Prefectural Agricultural Experiment Station. 17 fruits.

Lot G. Ikeda fruits from the orchard of Shôemon KAWAKAMI, Yamataki-mura, Senhoku-gun, Ôsaka-fu. 11 fruits.

#### *Fluted Ikeda*

These investigations in connection with the variation of the Ikeda variety brought out the Ikeda characters fairly well. The most important fact about the shape of fruit is that the Ikeda fruit, when it becomes over-ripe and soft, grows rather flat in shape, although the fundamental shape remains subglobose and truncate at ends, with basal sinuation and small calyx. When observed in bloom, flower buds are small, slender, terete, pointed at the apex, and less striated.

During the course of study, Prof. MIKI of Ôsaka Prefectural Agricultural Experiment Station and the author made a field observation of typical Ikeda plants in Idzumi Province. A plant picked up for experiment was located in the orchard of Mr. Shôemon KAWAKAMI. The plant was bearing typical round fruit when note was taken in the field, but when the crop was removed from the tree, it was found that the fruits were fairly flat. The detailed description of the tree and the fruit is given below:

Lot No. 52 and 53 of 1920. Ikeda tree of Shôemon KAWAKAMI, Yamataki-mura, Senhoku-gun, Ôsaka-fu. Stands on the top of a hill ridge in the Sanba orchard plot, located in the fourth row, east of the road along the ridge the fifth tree from the south, having distances of 2.33 m. each to north and south trees and 1.74 m. to S-W tree. It is

about 80 years old with an E-W spread of 4.19 m., N-S spread of 3.76 m., and height of 2.61 m. Habit is open, hemispherical, branches spreading and ends of side branches drooping, fine shoots numerous. Leaves small, sparse, flat open, not conspicuously hanging, not undulate, deep green. Soil clayey, hard pan beneath, straw mulched. The plant came from the Ikeda nursery district, and there are about 200 individuals of the same age. The fruit is sold after a long period of storage and is shipped to Tokyo before the end of May. Value of fruit on tree, 27 yen per 50 kwan (187.5 kg.) There are two old Ikeda individuals in the Sanba orchard, nearly dead, but still bearing a few late-bloom crops. The fruit of the chosen tree was typically round. Two branches, N and S, were used with their total crops. Their measurements are tabulated in Table 80\* and Table 81\*\*, respectively.

The fruit of both lots is nearly similar, being medium-sized, outline very irregular, irregularly grooved from the base, medium-flat in shape, fluted as in the flat Zairai of Nagasaki Prefecture Lots 3 and 8 of 1919, smaller quarter of fruits having a definitely sinuate base. Shape medium-flat, often truncate, shoulder high. Apex rather deeply depressed, areola very prominent, as in most of the fluted fruits, and navel less developed. Calyx small, lobes not well developed, especially in Lot No. 52, often irregular, varying from 3 to 7, thick and rather blunt. Surface very rough, deeply pitted, frequently wavy. More or less hard in texture, and often baggy. Little blemishes. In cross-section, rind thick, wavy, concave at the suture of segments, oil cells crowded, and elongated. Segment wall parallel with the outline, corner rather angular, inner end pointed, rather thick and making groups at the central column, which is medium-sized with medium-amount of hard pith. Size of segments rather irregular and that of central column also sometimes irregular. Pulp deep-colored, meaty, less juicy, coarsely grained, stretched, rather fibrous and vesicle wall often seen in cross-section. Quality of pulp is rather poor. In every respect it is inferior to the ordinary Owari Satsuma. The difference between both branches is not great, although the size and

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\* PL. XVIII, Fig. 2.

\*\* PL. XVIII, Fig. 3.



TABLE 80.

MEASUREMENT OF IKEDA SATSUMA FRUITS FROM N-BRANCH OF KAWAKAMI'S  
TREE IN IDZUMI PROVINCE. LOT NO. 52 OF 1920. TOTAL NUMBER  
OF FRUITS, 61 (NOS. 2126-2185 WITH 1 EXTRA).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.20 cm.	4.36 cm.	1.41	75.20 gm.	9.60 mm.	10.60	3.56 mm.	14.01 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	61	—	—	—	—	—	13	21.31%
Sinuate based fruits	61	—	—	—	—	—	23	37.70
Semi-sinuate based fruits	61	—	—	—	—	—	33	52.30
Areolated fruits	61	—	—	—	—	—	59	96.72
Frs. with undeveloped calyx lobes	61	—	—	—	—	—	23	37.70
Frs. with long narrow calyx lobes	61	—	—	—	—	—	1	1.64
Fruits containing seeds	61	—	—	—	—	—	1	1.64
Apical depression	61	44 72.13	13 21.31	4 6.56	0 0%	—	—	—
Apical dots	61	0 0	32 52.46	29 47.54%	—	—	—	—
Flatness of fruit	61	19 31.15	30 49.18	11 18.03	1 1.64	0 0%	—	—
Smoothness of fruit	61	0 0	0 0	11 18.03	50 81.97	0 0%	—	—
Thinness of rind	61	4 6.56	31 50.82	26 42.62	0 0	0 0%	—	—
Thinness of segment wall	61	23 37.70	35 57.38	3 4.92	0 0	0 0%	—	—
Color of pulp	61	31 50.82	30 49.18	0 0	0 0	0 0%	—	—
Size of central column	61	0 0	15 24.59	45 73.77	1 1.64	0 0%	—	—
Quantity of pith	61	0 0	3 4.92	53 86.89	5 8.20	0 0%	—	—
Quality of pulp	61	2 3.23	22 36.07	36 59.02	1 1.64	0 0%	—	—

TABLE 81.

MEASUREMENT OF IKEDA SATSUMA FRUITS FROM S-BRANCH OF KAWAKAMI'S  
TREE IN IDZUMI PROVINCE. LOT NO. 53 OF 1920. TOTAL NUMBER  
OF FRUITS, 143 (NOS. 2920-3071).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.18 cm.	3.96 cm.	1.46	73.09 gm.	9.04 mm.	10.36	3.28 mm.	13.82 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	143	—	—	—	—	—	10	% 6.99
Sinuate based fruits	143	—	—	—	—	—	71	49.65
Semi-sinuate based fruits	143	—	—	—	—	—	57	39.86
Areolated fruits	142	—	—	—	—	—	140	98.59
Frs. with undeveloped calyx lobes	143	—	—	—	—	—	107	74.83
Frs. with long narrow calyx lobes	143	—	—	—	—	—	0	0
Fruits containing seeds	142	—	—	—	—	—	8	5.59
Apical depression	142	<sup>83</sup> 58.45	<sup>42</sup> 29.58	<sup>17</sup> 11.97	<sup>0</sup> 0%	—	—	—
Apical dots	142	<sup>3</sup> 2.11	<sup>42</sup> 29.58	<sup>97</sup> 68.31%	—	—	—	—
Flatness of fruit	143	<sup>24</sup> 16.78	<sup>74</sup> 51.75	<sup>44</sup> 30.77	<sup>1</sup> 0.70	<sup>0</sup> 0%	—	—
Smoothness of fruit	142	<sup>0</sup> 0	<sup>4</sup> 2.82	<sup>84</sup> 59.15	<sup>54</sup> 38.03	<sup>0</sup> 0%	—	—
Thinness of rind	143	<sup>13</sup> 9.09	<sup>29</sup> 20.28	<sup>91</sup> 63.64	<sup>10</sup> 6.99	<sup>0</sup> 0%	—	—
Thinness of segment wall	143	<sup>27</sup> 18.88	<sup>89</sup> 62.24	<sup>22</sup> 15.38	<sup>4</sup> 2.80	<sup>1</sup> 0.70%	—	—
Color of pulp	143	<sup>104</sup> 72.73	<sup>31</sup> 21.68	<sup>8</sup> 5.59	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Size of central column	143	<sup>4</sup> 2.80	<sup>19</sup> 13.29	<sup>96</sup> 67.13	<sup>22</sup> 15.38	<sup>2</sup> 1.40%	—	—
Quantity of pith	143	<sup>0</sup> 0	<sup>15</sup> 10.49	<sup>125</sup> 87.41	<sup>3</sup> 2.10	<sup>0</sup> 0%	—	—
Quality of pulp	143	<sup>11</sup> 7.75	<sup>36</sup> 25.35	<sup>77</sup> 54.97	<sup>17</sup> 11.97	<sup>1</sup> 0.70%	—	—

the shape of fruits are a little different. It will be noted that the fruit of the northern branch, N, is larger in size but the weight is almost identical with that of the southern branch, S, and the latter is slightly better in quality.

During the trip to Nagasaki, two plants from Wakayama Prefecture, in the backyard of Kanekichi NAKAMURA of Obama-mura, Minamitakakigun, Nagasaki-ken, were called to the author's attention. At the time when the study was made, these plants were in off-year, but one of these trees was used for the investigation of individuality. The description of this plant is as follows:

Lot No. 61 of 1920. NAKAMURA's Kishû Ikeda, in Nagasaki Prefecture. The western tree, having an E-W spread of 3.46 m., N-S spread of 3.46 m., and height of 2.62 m., age about 15 years after planting. It is of rather upright habit, trunk slender, dividing into 5 major branches moderately open. Branches weak-looking, unpruned, and neglected, covered by lichens. Leaves few (defoliated), all erect and upright, a little boat-shaped, light-colored. The measurements of fruits are given in Table 82.\*

The fruits received from the entire plant were about 30 in all, but many of them were spoiled during transit, and only 17 were saved. They were medium-sized, rather flat with irregular outline like the preceding, truncate, surface oily, rough, pitted rather widely, apex shallowly concave, areola moderately prominent, navel the same. Base sinuous, more or less grooved. Calyx not very small, lobes not well developed. Tight-skinned, scabby, color slightly greenish. In cross-section, the rind medium in thickness, oil cells very large, segment wall medium-thin, central column rather large, with medium-large quantity of hard pith. Pulp medium in color, acidulous but fair in quality, pulp vesicles rather coarse, stretched, vesicle wall very visible in halved fruit, rather hard and fibrous. In every respect this is a truncate Ikeda, as seen in KAWAKAMI's orchard (Lot No. 52), showing an early stage of fluting of the surface.

These investigations show that the fruit of the Ikeda variety, when

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\* PL. XVIII, Fig. 4.

TABLE 82.

MEASUREMENT OF IKEDA SATSUMA FRUITS FROM NAKAMURA'S TREE AT  
OBAMA, NAGASAKI PREFECTURE. LOT NO. 61 OF 1920. TOTAL  
NUMBER OF FRUITS, 17 (NOS. 1072-1088).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.25 cm.	4.48 cm.	1.37	86.59 gm.	10.24 mm.	10.59	2.71 mm.	15.24 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		%
Naveled fruits	17	—	—	—	—	—	6	35.29
Sinuate based fruits	17	—	—	—	—	—	14	82.35
Semi-sinuate based fruits	17	—	—	—	—	—	1	5.88
Areolated fruits	17	—	—	—	—	—	6	35.29
Frs. with undeveloped calyx lobes	17	—	—	—	—	—	10	58.82
Frs. with long narrow calyx lobes	17	—	—	—	—	—	0	0
Fruits containing seeds	17	—	—	—	—	—	6	35.29
Apical depression	17	0 0	3 17.65	9 52.94	2 29.41%	—	—	—
Apical dots	17	0 0	0 0	17 100.00%	—	—	—	—
Flatness of fruit	17	1 5.88	5 29.41	8 47.06	3 17.65	0 0%	—	—
Smoothness of fruit	17	2 11.76	1 5.88	4 23.53	10 58.82	0 0%	—	—
Thinness of rind	17	4 23.53	8 47.06	3 17.65	2 11.76	0 0%	—	—
Thinness of segment wall	17	6 35.29	6 35.29	5 29.41	0 0	0 0%	—	—
Color of pulp	17	0 0	7 41.18	9 52.94	0 0	1 5.88%	—	—
Size of central column	17	4 23.53	3 17.65	9 52.94	1 5.88	0 0%	—	—
Quantity of pith	17	0 0	10 58.82	7 41.18	0 0	0 0%	—	—
Quality of pulp	17	0 0	2 16.67	4 33.33	4 33.33	2 16.67%	—	—

the total crop of a plant or a definite part of it is observed, may be more or less flat in shape, while sampling at random from a large number of fruits tends to present small round fruits, because the plant is very productive in general, yielding a considerably large number of round fruits of small size, which are most readily picked up by chance. Flat fruits of the Ikeda, however, are truncate, not conical, and when enlarged sidewise, fluting or irregularity of the outline always happens. The sinuation of the stem-end and small calyx with undeveloped lobes are also characteristic, as stated repeatedly. The rind is generally not very thin, deeply pitted, with rather thick segment wall and large amount of hard pith. The pulp is deep-colored, meaty, hard, with coarse vesicles stretched lengthwise, not forming a fine reticulation.

### THE MARU SATSUMA, A NEW VARIETY RELATED TO ZAIRAI

In a very isolated place called Kadzuragahata, in the village of Aoe, Ôita Prefecture, a peculiar variety of the Satsuma orange was found in 1920. There were two trees apparently of the same age, having an extremely upright habit of branches and uniformly globose fruits. A tree belonging to Benzô KAWANO was used for statistical study, and is described as follows:

Lot No. 64 of 1920. KAWANO's Maru Satsuma at Kadzuragahata, Ôita Prefecture. Located on a slope inclined to the S-E, second terrace above the road, 4th tree west of a very old Ikeda tree. The tree is about 40 years old, of unknown origin, and was planted 5.2 m. away from the neighbouring Owari trees, it has an E-W spread of 5.78 m., N-S spread of 2.62 m., and height of 4.04 m. The branches are of utmost upright habit, with a large number of upright and straight shoots, none of them drooping at the ends. Leaves also standing upright, slender and sharply pointed, angle of attachment being very sharp. Blade straight, not bending downward, never undulate, deep colored. The foliage is well contrasted with those of the neighbouring Owari trees, all of which have hanging leaves, none standing upright. Soil fertile, more or less sandy

with small pebbles. The measurements of fruits from the whole tree are given in Table 83.\*

The fruit is very peculiar. Size medium-small, ranging from medium to very small, shape uniformly medium to medium-high, appearing very round through its regular outline and rounded side curvature. Texture compact, very smooth, blackens when injured by pressure. Apex very much rounded, often projecting to form a convex styler end, areola is present but not prominent, navel almost undeveloped. Stem-end sinuate, not broadly concave and not grooved. Calyx very characteristic, body almost undeveloped, lobes very frequently elongated, otherwise undeveloped. In cross-section, rind is tight, thick, oil cells round and dispersed, rag very solid and hard, pure white inside. Segment small, wall undulate outside, inner end quite rounded, rather difficult to separate. Central column rather small and solid, filled with hard pith. Pulp rather light colored, coarse, solid, and poor quality, often changing disagreeably to bitterish taste, vesicle wall thick, unseparable. These characters are partly associated with the poor condition of the tree, as observed in KAGAYAMA's tree before its death (Lot No. 9 of 1919).

Another tree in the orchard of Isokichi KAWANO looked older and was in a still worse condition. It was considered to be the mother tree of the former, and looked entirely similar in its characteristics. The fruits borne on this plant were measured, the average of which is given below :

Girth	Diameter	D/H Index	Weight	Calyx	No. Segm'ts.	Rind	Center
16.93 cm.	4.0 cm.	1.35	61.70 gm.	10.7 mm.	11.0	26.67 mm.	3.67 mm.

These fruits had no navel ; had a flattened base, undeveloped calyx lobes, medium outline, even surface, and quite green rind when picked on October 20th. Rind was medium-thick, segment wall medium-thin, pulp light colored and acid, central column medium-small and pith much.

\* PL. XVIII, Fig 5.

TABLE 83.

MEASUREMENT OF KAWANO'S MARU SATSUMA FRUITS FROM KADZURA-  
GAHATA, AOE-MURA, OITA PREFECTURE. LOT NO. 64 OF 1920.  
TOTAL NUMBER OF FRUITS, 196 (NOS. 5467-5110).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.09 cm.	4.17 cm.	1.30	63.20 gm.	10.44 mm.	9.88	2.67 mm.	10.64 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	196	—	—	—	—	—	4	% 2.04
Sinuate based fruits	196	—	—	—	—	—	146	74.49
Semi-sinuate based fruits	196	—	—	—	—	—	16	7.14
Areolated fruits	196	—	—	—	—	—	125	63.78
Frs. with undeveloped calyx lobes	189	—	—	—	—	—	27	14.24
Frs. with long narrow calyx lobes	189	—	—	—	—	—	60	31.75
Fruits containing seeds	196	—	—	—	—	—	0	0
Apical depression	196	0 0	0 0	19 9.69	177 90.31%	—	—	—
Apical dots	196	6 3.06	53 27.04	139 69.90%	—	—	—	—
Flatness of fruit	196	0 0	25 12.76	87 44.39	72 36.73	12 6.12%	—	—
Smoothness of fruit	196	171 87.24	20 10.20	5 2.55	0 0	0 0%	—	—
Thinness of rind	196	45 22.96	79 40.31	62 31.63	9 4.59	1 0.51%	—	—
Thinness of segment wall	196	27 13.78	97 49.49	67 34.18	4 2.04	1 0.51%	—	—
Color of pulp	196	45 22.96	115 58.67	27 13.78	9 4.59	0 0%	—	—
Size of central column	196	0 0	3 1.53	97 49.49	62 31.63	34 17.35%	—	—
Quantity of pith	196	26 13.27	103 52.55	66 33.67	1 0.51	0 0%	—	—
Quality of pulp	191	23 12.04	69 36.13	81 42.44	13 6.81	5 2.62%	—	—

These characters are similar to the former lot, although the fruits were immature.

Judging from the general character of the fruits, this variety is nearest to the Ikeda, but the habit of the tree is entirely different, being extremely upright and never drooping whenever the end branches run very horizontal. This is a very remarkable new variety of the Satsuma orange, although no economic value can be attributed to it. Presumably this variety has arisen either from the Ikeda or the Zairai variety, because both are present in this section. The oldest Ikeda tree was found in the orchard of Isokichi KÔNO, and is aged between 80 to 90 years, having typical habit and leaves. The Zairai plant is called here "Rifujin", the oldest name of the Satsuma. It is said that the oldest surviving Rifujin tree is about 150 years old. It is interesting that this common name is not known in the Aoe and Tsukumi regions proper, and possibly its origin can be attributed to the migration of plants from Fukuoka Prefecture, which crossed the mountain range beyond the border, and did not come from Yatsushiro by the southern route. The purplish soil of Kadzuragahata is very famous due to its high fertility, and the budwoods of the Satsuma were very frequently taken down to the Tsukumi region, due to the ideal condition of the trees supplying the buds. The Zairai must have been distributed in this way.

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# **BOOK IV**

**(SUPPLEMENT)**



## INDIVIDUALITY INVESTIGATIONS IN THE UNITED STATES

### OWARI VARIETY OF RECENT IMPORTATION

The Satsuma plants cultivated in the United States are based upon repeated introductions from Japan from time to time. Since they did not come through a single importation, various varieties among them are to be expected. The preliminary survey of the author brought to light a fact that there are at least three varieties occurring there, that is, Ikeda, Owari, and Zairai. The last variety was soon eliminated from propagation, and when the author was in the Gulf States in 1921, they had all disappeared. In a few groves, where the Satsuma had been identified as Zairai, they turned out to be Owari.

In order to obtain more concrete data of the varieties of the Satsuma orange grown in the United States, the author applied his individuality method upon the various sample trees chosen for study. The sampling was made exactly in the same way as in Japan, and the fruits were sent to Washington, D. C., where they were measured and tabulated. The aim in presenting the data here is purely one of scientific interest and does not involve any intention to judge the product of the individual growers who kindly offered their material for investigation. The author is indebted to Dr. O. F. E. WINBERG, President of Gulf States Citrus Exchange, for giving facilities for conducting this study.

Attention was first turned to the Owari variety, which was most abundantly introduced directly from Japan during the period of the Satsuma boom between 1906 and 1912. These directly imported trees were chiefly typical Owari Satsumas. The first two lots (Nos. 71 and 72) studied during the winter of 1921 were representative trees in HUNTER's tract of Mr. REYNOLDS's orchard, in Bayview, Mobile county, Alabama, U. S. A. The plants were imported from Japan by the SAIBARA nurseries in 1912. The description of these trees follows:

Lot No. 71 of 1921. Tree No. 114, row No. 7 from the main road. Single branch was used for fruits. This is a typical tree with long shoots, branches running at random in every direction and finally bent down by the weight of the fruit, their number being extremely few. Center of the plant is wide open; leaves large and broad. The plant was chosen for study as one bearing average sized fruits, representing the prevailing condition of the orchard. All the trees in the orchard were just recovering their vigor from injury from cold received several years ago. The drouth of the summer caused this year's fruits to be very small in size and early in coloring, although the next year's crop seemed to be normal. The measurements of fruits are given in Table 84.\*

The fruit is rather small-sized, flat, fairly polished, with moderately depressed apex, undeveloped areola and large calyx having fairly well developed lobes. In cross-section, rind is moderately thin, segment wall is also medium-thin, central column rather small with medium amount of pith. Pulp fairly deep-colored, taste only fair in quantity.

Lot No. 72 of 1921. Unnumbered tree, 4th row and 3rd plant from Mr. HUNTER's house, This plant, being nearer to the bay, did not suffer much by the drouth, and looked very vigorous. The appearance of the tree is exactly like the Owari seen in Ôchô and Ikiriki. It is a very typical Owari in every respect. The plant is of upright habit, with a relatively small number of very large leaves. The measurements of fruits are given in Table 85.

The fruit of this lot is much larger than the preceding, the shape is rather flat, apex depressed, areola and navel little developed, base broadly shallow concave, and calyx lobes rather poorly developed. The surface is rather smooth, rind rather thick, segment wall medium-thin, central column rather small and there is a more or less large amount of pith. Pulp medium deep-colored, quality of pulp only fair.

The second place from which the material was taken is BURGHARDT's orchard in Foley, Baldwin county, Alabama, Most of the plants in the orchard were imported directly from Japan through the Irvin Japanese

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\* PL. XIX, Fig. 1.

TABLE 84.

MEASUREMENT OF FRUITS OF OWARI SATSUMA FROM HUNTER'S TRACT  
OF REYNOLD'S ORCHARD AT BAY VIEW, ALABAMA. LOT NO. 71 OF  
1921. TOTAL NUMBER OF FRUITS, 63 (NOS. 6251-6313).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.44 cm.	3.80 cm.	1.38	53.77 gm.	11.51 mm.	10.62	2.14 mm.	9.21 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	63	—	—	—	—	—	1	1.59%
Sinuate based fruits	63	—	—	—	—	—	2	3.18
Semi-sinuate based fruits	63	—	—	—	—	—	11	17.46
Areolated fruits	63	—	—	—	—	—	3	4.76
Frs. with undeveloped calyx lobes	63	—	—	—	—	—	30	47.62
Frs. with long narrow calyx lobes	63	—	—	—	—	—	0	0
Fruits containing seeds	63	—	—	—	—	—	28	44.44
Apical depression	63	0 0	17 26.98	45 71.43	1 1.59%	—	—	—
Apical dots	63	1 1.59	16 25.40	46 73.01%	—	—	—	—
Flatness of fruit	63	13 20.64	28 44.44	17 26.98	5 7.94	0 0%	—	—
Smoothness of fruit	63	54 85.71	5 7.94	4 6.35	0 0	0 0%	—	—
Thinness of rind	60	7 11.66	43 71.67	10 16.67	0 0	0 0%	—	—
Thinness of segment wall	60	3 5.00	55 91.67	2 3.33	0 0	0 0%	—	—
Color of pulp	60	12 20.00	37 61.67	11 18.33	0 0	0 0%	—	—
Size of central column	60	0 0	1 1.67	37 61.67	20 33.33	2 3.33%	—	—
Quantity of pulp	60	2 3.33	8 13.33	49 81.67	1 1.67	0 0%	—	—
Quality of pulp	60	0 0	27 45.00	33 55.00	0 0	0 0%	—	—

TABLE 85.

MEASUREMENT OF FRUITS OF OWARI SATSUMA FROM HUNTER'S TRACT OF REYNOLD'S ORCHARD AT BAY VIEW, ALABAMA. LOT NO. 72 OF 1921.

TOTAL NUMBER OF FRUITS, 13 (NOS. 6251-6313).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.43 cm.	4.82 cm.	1.35	107.95 gm.	9.67 mm.	10.46	2.73 mm.	9.38 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	13	—	—	—	—	—	0	% 0
Sinuate based fruits	13	—	—	—	—	—	0	0
Semi-sinuate based fruits	13	—	—	—	—	—	7	53.85
Areolated fruits	13	—	—	—	—	—	4	30.77
Frs. with undeveloped calyx lobes	13	—	—	—	—	—	9	75.00
Frs. with long narrow calyx lobes	12	—	—	—	—	—	0	0
Fruits containing seeds	12	—	—	—	—	—	4	30.77
Apical depression	13	<sup>2</sup> 15.38	<sup>7</sup> 53.85	<sup>4</sup> 30.77	<sup>0</sup> 0%	—	—	—
Apical dots	13	<sup>1</sup> 7.69	<sup>3</sup> 23.08	<sup>9</sup> 69.23%	—	—	—	—
Flatness of fruit	13	<sup>3</sup> 23.08	<sup>9</sup> 69.23	<sup>1</sup> 7.69	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Smoothness of fruit	13	<sup>3</sup> 23.08	<sup>9</sup> 69.23	<sup>1</sup> 7.69	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Thinness of rind	13	<sup>0</sup> 0	<sup>7</sup> 53.85	<sup>2</sup> 15.38	<sup>3</sup> 23.08	<sup>1</sup> 7.69%	—	—
Thinness of segment wall	13	<sup>0</sup> 0	<sup>13</sup> 100.00	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Color of pulp	13	<sup>0</sup> 0	<sup>9</sup> 69.23	<sup>4</sup> 30.77	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Size of central column	13	<sup>0</sup> 0	<sup>0</sup> 0	<sup>1</sup> 7.69	<sup>3</sup> 23.08	<sup>9</sup> 69.23%	—	—
Quantity of pith	13	<sup>1</sup> 7.69	<sup>5</sup> 38.46	<sup>7</sup> 53.85	<sup>0</sup> 0	<sup>0</sup> 0	—	—
Quality of pulp	13	<sup>0</sup> 0	<sup>0</sup> 0	<sup>13</sup> 100.00	<sup>0</sup> 0	<sup>0</sup> 0%	—	—

Nurseries Company. A little material was studied from this orchard from the plants listed below, as a regular large lot of fruits sent to Washington was used by mistake for other purposes.

Lot No. 73 of 1921. Plot B, 9th row from south, 5th tree from west. Pyramid-shaped tree very upright in habit, heavily bearing but not drooping much. Leaves on the north side of the tree are very large and undulate, quite typical of Owari. In total, 17 fruits from a branch were measured, as shown in Table 86\*.

The fruit is fairly large in size, moderately depressed, apex shallowly concave or flat, with poorly developed navel. Base broadly depressed, with very few sinuate ones. Surface more or less smooth and the rind is very thin. Segment wall medium-thin, central column rather small, with medium-small-amount of pith. Pulp rather light-colored, and quality only fair.

Lot No. 74 of 1921. Plot B, 9th row from south, 6th tree from west. A well-bearing tree of hemispherical shape, having an E-W spread of 3.46 m., N-S spread of 4.04 m., and height of 1.74 m. Branches well spreading, with many leaves rather crowded, but pocket leaves considerably large and hanging. The tree is unpruned and is in an over-vigorous condition, with many branches and even pocket shoots bearing. A lot of 10 fruits from a single branch given in Table 87 were measured.

The fruit is large, flat, well colored homogeneously, polished and well glazed. Apex equally shallow depressed, both areola and navel not developed. Base broadly shallow concave, calyx with undeveloped lobes. In cross-section, rind thin, segment wall medium-thin, central column medium sized, pith medium in amount. Pulp medium-deep colored, quality fair.

Two fruits (Lot No. 75, Nos. 6362-6363) were taken from an unknown tree in the same orchard. The average characters are as follows :

Girth	Diameter	D/H Index	Wt.	No. Segm'ts.	Calyx	Rind	Center	Seed
2.14 cm.	4.75 cm.	1.43	113.40 gm.	11.00	9.5 mm.	2.13 mm.	13.50 mm.	6 in 1 fr.

\* PL. XIX, Fig. 2.



TABLE. 86.

MEASUREMENT OF FRUITS FROM BURGHARDT'S OWARI SATSUMA TREE AT  
FOLEY, ALABAMA. LOT NO. 73 OF 1921. TOTAL NUMBER OF  
FRUITS, 17 (NOS. 6335-6351).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.66 cm.	4.61 cm.	1.36	93.39 gm.	9.59 mm.	10.50	1.96 mm.	10.71 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	17	—	—	—	—	—	2	11.76%
Sinuate based fruits	17	—	—	—	—	—	1	5.88
Semi-sinuate based fruits	17	—	—	—	—	—	8	47.06
Areolated fruits	17	—	—	—	—	—	2	11.76
Frs. with undeveloped calyx lobes	17	—	—	—	—	—	5	29.41
Frs. with long narrow calyx lobes	17	—	—	—	—	—	0	0
Fruits containing seeds	13	—	—	—	—	—	7	41.18
Apical depression	17	0 0	6 35.29	11 64.71	0 0%	—	—	—
Apical dots	17	0 0	11 64.71	6 35.29%	—	—	—	—
Flatness of fruit	17	4 23.53	10 58.82	3 17.65	0 0	0 0%	—	—
Smoothness of fruit	17	1 5.88	7 41.18	7 41.18	0 0	0 0%	—	—
Thinness of rind	13	13 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	13	0 0	1 7.69	12 92.31	0 0	0 0%	—	—
Color of pulp	13	0 0	0 0	13 100.00	0 0	0 0%	—	—
Size of central column	13	0 0	0 0	9 69.23	4 30.77	0 0%	—	—
Quantity of pith	13	0 0	0 0	11 84.62	2 15.38	0 0%	—	—
Quality of pulp	13	0 0	0 0	13 100.00	0 0	0 0%	—	—

TABLE 87.

MEASUREMENT OF FRUITS FROM BURGHARDT'S SECOND OWARI SATSUMA TREE AT FOLEY, ALABAMA. LOT NO. 74 OF 1921. TOTAL NUMBER OF FRUITS, 10 (NOS. 6352-6361).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.06 cm.	4.19 cm.	1.37	85.05 gm.	8.20 mm.	11.30	2.00 mm.	10.50 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	10	—	—	—	—	—	1	% 10.00
Sinuate based fruits	10	—	—	—	—	—	0	0
Semi-sinuate based fruits	10	—	—	—	—	—	1	10.00
Areolated fruits	10	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	10	—	—	—	—	—	7	70.00
Frs. with long narrow calyx lobes	10	—	—	—	—	—	0	0
Fruits containing seeds	10	—	—	—	—	—	9	—
Apical depression	10	0 0	4 40.00	6 60.00	0 0%	—	—	—
Apical dots	10	0 0	8 80.00	2 20.00%	—	—	—	—
Flatness of fruit	10	3 30.00	3 30.00	3 30.00	1 10.00	0 0%	—	—
Smoothness of fruit	10	5 50.00	5 50.00	0 0	0 0	0 0%	—	—
Thinness of rind	10	6 60.00	4 40.00	0 0	0 0	0 0%	—	—
Thinness of segment wall	10	1 10.00	9 90.00	0 0	0 0	0 0%	—	—
Color of pulp	10	2 20.00	8 80.00	0 0	0 0	0 0%	—	—
Size of central column	10	0 0	1 10.00	8 80.00	1 10.00	0 0%	—	—
Quantity of pith	10	0 0	5 50.00	5 50.00	0 0	0 0%	—	—
Quality of pulp	10	0 0	1 10.00	9 90.00	0 0	0 0%	—	—

They were typical large Owari fruits with depressed ends and harshed surface.

There are 29 remaining fruits from a tree in BURGHARDT's orchard, the measurements of which are given below :

Girth	Diameter	D/H Index	Wt.	No. Segm'ts.	Calyx	Rind	Center	Seed
18.57 cm.	4.32 cm.	1.37	91.86 gm.	9.43	8.80 mm.	—	—	2(6.67%)

From all available data given above, these directly imported Satsuma plants in BURGHARDT's orchard are Owari variety, and such contradictory characters as a large percentage of undeveloped calyx lobes, shallow depression of both ends, comparative thickness of segment wall, and not particular good quality of pulp, are all attributed to the local conditions, so widely different from that of Japan. These diversities of nature once gave rise to a mistaken conception of them as Zairai, but it was reported later to the writer that the tree bore normal Owari fruits of desirable character for several years.

The next investigation was then made in the POTTER tract, Grand Bay Land Company, at Grand Bay, Mobile County, Alabama, where again Satsumas imported directly through the Irvin Japanese Nurseries are extensively planted. The detail of a plant chosen for study is as follows :

Lot No. 77 of 1921. HEINRICH Block in the POTTER tract. 10 year old tree, located in the 3rd row from the east, 4th tree from the north, having a girth of trunk 45 cm., divided into fascicular form near the ground, with an E-W spread of 3.46 m., N-S spread of 3.46 m., and height of 3.46 m. Branches thick, strong, few in number, hanging down only by the weight of the fruit, shoots standing up rather irregularly. Leaves rather small, but very deep-colored, those on the south side most typical of the Owari variety, inside leaves very large and wrinkled. Measurements of total crops of a S-W branch are given in Table 88.\*

The fruit is extremely large and flat, very well colored and fairly smooth, with a mixture of roundish rough fruit. Apex broadly depressed,

\* PL. XIX, Fig. 4,

TABLE 88.

MEASUREMENT OF FRUITS FROM AN OWARI SATSUMA TREE OF POTTER TRACT, GRAND BAY, ALABAMA. LOT NO. 77 OF 1921. TOTAL NUMBER OF FRUITS, 54 (NOS. 6679-6732).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.10 cm.	4.73 cm.	1.42	118.61 gm.	9.79 mm.	10.94	2.41 mm.	13.78 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	54	—	—	—	—	—	6	11.11
Sinuate based fruits	54	—	—	—	—	—	11	20.37
Semi-sinuate based fruits	54	—	—	—	—	—	23	42.59
Areolated fruits	54	—	—	—	—	—	2	3.70
Frs. with undeveloped calyx lobes	48	—	—	—	—	—	6	11.11
Frs. with long narrow calyx lobes	48	—	—	—	—	—	0	0
Fruits containing seeds	54	—	—	—	—	—	34	65.38
Apical depression	54	5 9.26	34 62.96	15 27.78	0 0%	—	—	—
Apical dots	54	1 1.85	25 46.30	23 51.85%	—	—	—	—
Flatness of fruit	54	31 57.41	19 35.19	4 7.41	0 0	0 0%	—	—
Smoothness of fruit	54	10 18.52	26 48.15	18 33.33	0 0	0 0%	—	—
Thinness of rind	54	43 82.69	8 15.38	1 1.92	0 0	0 0%	—	—
Thinness of segment wall	54	18 35.29	25 49.02	5 9.80	3 5.88	0 0%	—	—
Color of pulp	54	49 94.23	3 5.77	0 0	0 0	0 0%	—	—
Size of central column	54	1 1.92	5 9.62	29 55.77	15 28.85	2 3.85%	—	—
Quantity of pith	54	2 3.85	8 15.38	42 80.77	0 0	0 0%	—	—
Quality of pulp	50	20 40.00	26 52.00	4 8.00	0 0	0 0%	—	—

areola and navel not developed. Base mostly broad concave, rarely sinuate in rough fruits, calyx large, lobes generally well developed. In cross-section, rind is very thin, segment wall medium-thin, central column variable in size, generally medium-sized, more or less large amount of pith is contained. Pulp very deep-colored and of good quality.

There were eight more fruits (Lot No. 78, Nos. 6873-6880) coming from an unknown tree in the same orchard, which were measured as follows :

Girth	Diameter	D/H Index	Wt.	Calyx	No. Segm'ts.	Naveled fruits	Rind	Center	Seedy fruits
22.3 cm.	4.80 cm.	1.48	gm. 116.25	mm. 11.63	12.17	5 (62.50%)	mm. 2.88	mm. 17.08	0

These fruits have broadly depressed ends, thin rind and segment wall, medium-small sized central column with small amount of pith, and good flavored pulp.

There were occasionally detected, in the sizing machine bins, fruits which resemble those of Ikiriki Satsumas, having an extremely large, flat outline, smooth surface, broadly depressed ends, very deeply colored rind like Wase, and extremely good quality, as the preceding. A random pick of such fruits (from the same orchard) were measured as follows (Lot No. 76,\* 5 fruits, Nos. 6370-6374) :

Girth	Diameter	D/H Index	Wt.	Calyx	No. Segm'ts.	Naveled fruits	Rind	Center	Seedy fruits
21.02 cm.	4.68 cm.	1.43	—	mm. 11.20	11.80	3(60%)	mm. 2.10	mm. 12.20	1

The last lot of imported Owari Satsumas studied in Alabama was George ILETT's fruits, the trees having been bought from the SAIBARA nurseries. The orchard is in Fowl River, Mobile County, Alabama. Description follows :

Lot No. 79 of 1921. ILETT's Saibara Owari tree about 9 years old. Trunk about 10 cm. high, 20 cm. in girth, then dividing into 3 major branches, 100 cm., 50 cm., and 55 cm. each in length. Branchlets all elongated, leaves rather dense, and undulate. The measurements of fruits are given in Table 89.\*\*

\* PL. XIX, Fig. 3.

\*\* PL. XIX, Fig. 5.

TABLE. 89

MEASUREMENT OF FRUITS FROM AN OWARI SATSUMA TREE OF ILETT'S  
ORCHARD AT FOWL RIVER, ALABAMA. LOT NO. 79 OF 1921. TOTAL  
NUMBER OF FRUITS, 132 (NOS. 6733-6864).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.81 cm.	5.05 cm.	1.43	141.02 gm.	10.69 mm.	11.24	2.27 mm.	16.98 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	132	—	—	—	—	—	37	28.03%
Sinuate based fruits	132	—	—	—	—	—	2	1.52
Semi-sinuate based fruits	132	—	—	—	—	—	8	6.06
Areolated fruits	132	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	132	—	—	—	—	—	3	2.27
Frs. with long narrow calyx lobes	132	—	—	—	—	—	0	0
Fruits containing seeds	132	—	—	—	—	—	12	9.09
Apical depression	132	15 11.36	85 64.39	31 23.48	1 0.76%	—	—	—
Apical dots	132	1 0.76	33 25.00	98 74.24%	—	—	—	—
Flatness of fruit	132	83 62.88	49 21.97	16 12.12	4 3.03	0 0%	—	—
Smoothness of fruit	132	34 25.76	67 50.76	30 22.73	1 0.76	0 0%	—	—
Thinness of rind	126	118 93.65	8 6.35	0 0	0 0	0 0%	—	—
Thinness of segment wall	126	82 65.08	40 31.75	4 3.18	0 0	0 0%	—	—
Color of pulp	126	104 82.54	21 16.67	1 0.79	0 0	0 0%	—	—
Size of central column	126	12 9.68	24 19.35	74 59.68	12 9.68	2 1.61%	—	—
Quantity of pith	126	0 0	3 2.38	93 73.81	28 22.22	2 1.59%	—	—
Quality of pulp	126	93 77.50	24 20.00	2 16.67	1 0.83	0 0%	—	—

The fruit is extremely large sized and very flat, apex widely depressed, base usually flat and gradually concave, not sinuate at all, usually shallowly furrowed. Surface smooth, not deep-colored, oil cell dots conspicuously large and dispersed. Calyx very large and lobes very well developed. In cross-section, rind thin, segment wall rather thin, central column variable in size, with varying quantity of pith. Pulp deep-colored, quality conspicuously good.

In conclusion, it can be easily noted that the Owari Satsuma, directly imported from Japan, bears fruits almost exactly similar to those found in Japan, and the crops from well cared orchards are almost identical with the product of the best Japanese individuals, such as those found in Nagasaki and Kagoshima Prefectures. The climatic conditions, chiefly the higher temperature, seems to act favorably on the Owari Satsuma in causing it to yield fruits of better quality.

### OWARI VARIETY OF EARLY IMPORTATION

There are a large number of Owari trees in the Gulf States propagated and distributed by the Glen Saint Mary Nurseries and others, using budwoods from trees of early importation. They were temporarily called "Glen St. Mary Owari", because a great majority of them were at least descended from plants disseminated by this company. The general character of these plants agrees with the common Owari, but the fruit is somewhat inferior to that of the best individuals of the directly imported trees. From the point of view of the individuality differences existing within the same variety, these descendants of the early imported Owari Satsumas are probably such as have not passed severe test and selection, as compared to those which came directly from Owari Province in Japan. These plants are easily affected by undesirable conditions of the soil, and the fruit does not grow so large as the latter even when conditions are extremely favorable. Two lots of this kind of Owari were investigated and the measurements of fruits were made. The first lot is as follows:

Lot No. 82 of 1921. Owari Satsuma tree in the orchard of Roy SLEEP, Irvington, Mobile County, Alabama. Stands on Plot A 5, inter-

planted with pecan trees, distance between rows, 14.52 m. It has an E-W spread of 4.6 m., N-S spread of 4.67 m., and height of 3.03 m. Trunk on trifoliate stock with swollen crown, the first branching occurs at about 2.62 m. from the ground, branches being very crowded, shoots stretched every direction and elongated. Leaves medium-sized, rather crowded, not curled as those of the Ikeda variety. Soil sandy.

The fruit is medium-sized, flat or medium-flat, rarely mixed with rather tall ones, beautifully colored, medium-smooth on the average, apex broadly or narrowly depressed, oil cell dots present or sparse near the stylar end, which is often sinuous at the stylar point, navels and areolas very few. Base rather deeply depressed, or broad sinuate, or sinuate, shallowly grooved and uneven thereby but never truncate. Calyx rather small, some with undeveloped lobes, thickness medium. Oil cells on the surface often very large and convex. In cross-section, number of segments rather few, rind thin, segment wall also thin, central column medium-sized, pith medium or little in amount. Pulp deep-colored, flavor very delicious. For fruit measurements, see Table 90.\*

When fruits were on the tree, their outline looked rather round, but after being picked, flat ones were found to be abundant, and not very different in the D/H index from the recently imported Owari Satsumas. The calyx is rather small, but it was observed that the calyx of Ikeda fruits is still smaller. It seems probable that the reduction in the size of the calyx is due to the great abundance of flowers coming in the bearing period following the year of rest, so that while a large calyx could be proof of Owari or Wase Satsumas, small size does not prove it to be something else. This is especially true when injury from cold is so frequent and uniform bearing is thus disturbed, as in the Gulf States.

The next lot of the "Glen St. Mary Owari" was chosen from the orchard of Don H. PENNEL, Irvington, Mobile County, Alabama. The description of the plant is as follows:

Lot No. 83 of 1922. PENNEL's Owari Satsuma. Third row from south fence, 7th tree from east. It has an E-W spread of 4.82 m., N-S

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\* PL. XX, Fig. 1.



TABLE 90.

MEASUREMENT OF FRUITS OF OWARI SATSUMA FROM SLEEP'S ORCHARD  
AT IRVINGTON, ALABAMA. LOT NO. 82 OF 1921. TOTAL NUMBER  
OF FRUITS, 135 (NOS. 6414-6548).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.78 cm.	4.37 cm.	1.37	73.28 gm.	9.01 mm.	10.13	2 36 mm.	13.30 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	135	—	—	—	—	—	7	% 5.19
Sinuate based fruits	135	—	—	—	—	—	23	17.04
Semi-sinuate based fruits	135	—	—	—	—	—	88	65.18
Areolated fruits	135	—	—	—	—	—	11	8.15
Frs. with undeveloped calyx lobes	134	—	—	—	—	—	32	23.70
Frs. with long narrow calyx lobes	134	—	—	—	—	—	1	0.74
Fruits containing seeds	133	—	—	—	—	—	25	18.79
Apical depression	135	16 11.85	56 41.48	63 46.67	0 0%	—	—	—
Apical dots	135	2 1.48	67 49.63	66 48.89%	—	—	—	—
Flatness of fruit	135	35 25.93	54 40.00	45 33.33	1 0.74	0 0%	—	—
Smoothness of fruit	135	29 21.48	66 48.89	34 25.19	5 3.70	1 0.74%	—	—
Thinness of rind	133	113 84.96	19 14.29	1 0.75	0 0	0 0%	—	—
Thinness of segment wall	133	114 85.71	25 18.80	4 3.01	0 0	0 0%	—	—
Color of pulp	133	120 90.23	13 9.77	0 0	0 0	0 0%	—	—
Size of central column	133	0 0	18 13.53	96 72.18	16 12.03	3 2.55%	—	—
Quantity of pith	133	0 0	3 2.55	113 84.96	14 10.05	3 2.55%	—	—
Quality of pulp	181	85 64.89	38 29.01	7 5.34	1 0.76	0 0%	—	—

spread of 5.50 m., and height of 2.33 m. Trunk thick, 50 cm. in girth, dividing into 4 major branches; branches wide open, with tips bending down. Leaves rather crowded, with short internodes, small in size except at the center of the tree, where they are large and hanging. Soil more or less deep-colored, clayey loam, mulched heavily with hay and pecan leaves. The measurements of fruits are given in Table 91.\*

The fruit is medium-sized or rather small, mostly medium-flat, apparently very flat due to a remarkable depression at both ends, though the shoulder of the fruit is rather high, giving a somewhat rectangular appearance. Apex very much depressed and sinuate at the styler point, navel mostly closed, areola not very developed, but often rather prominent, and the enclosed space of the depressed area is often uneven, probably caused by rough areola dotting. Base deeply depressed, often deeply grooved, not sinuate. Calyx rather small, lobes well developed, thin, color not deep, disk entirely covered. Surface rather rough, much pitted, oil cell dots rather large and many of them convex, color deep for average, but not so intense as the preceding, rather soft. In the cross-section, rind is more or less thick, segment wall rather thin, central column rather large but the amount of pith is medium or rather little. Pulp deep-colored and of rather good quality.

There were a few small lots of so-called "Glen St. Mary Owari" studied from time to time, and on the principle of offering all data obtained, these figures are briefly quoted as follows:

Lot No. 80 of 1921. Random pick from the orchard of NOBLES, Mobile County, Alabama. 6 fruits (Nos. 6327-6332).

Girth	Height	D/H Index	Wt.	Calyx	Navel	Areola	No. Segm'ts.	Rind	Center	Seedy frs.
19.27 cm.	4.50 cm.	1.36	gm. 89.76	mm. 9.00	1 (16.67%)	1 ( " )	10.83	mm. 2.00	mm. 11.50	3 (50%)

Lot No. 81 of 1921. A sample pick from Tree F 25 Oi, in the orchard of HILCHER, Foley, Baldwin County, Alabama. 2 fruits (Nos. 6364-6365).

\* PL. XX, Fig. 2.

TABLE 91.

MEASUREMENT OF FRUITS OF PENNEL'S OWARI SATSUMA PLANT AT  
IRVINGTON, ALABAMA. LOT NO. 83 OF 1921. TOTAL NUMBER  
OF FRUITS, 172 (NOS. 6881-7052).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.88 cm.	4.53 cm.	1.40	92.82 gm.	9.23 mm.	10.24	3.15 mm.	16.29 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	172	—	—	—	—	—	3	1.74%
Sinuate based fruits	172	—	—	—	—	—	13	7.56
Semi-sinuate based fruits	712	—	—	—	—	—	88	51.16
Areolated fruits	172	—	—	—	—	—	30	17.44
Frs. with undeveloped calyx lobes	171	—	—	—	—	—	16	9.30
Frs. with long narrow calyx lobes	171	—	—	—	—	—	2	1.16
Fruits containing seeds	172	—	—	—	—	—	81	47.65
Apical depression	172	83 48.26	67 38.95	22 12.79	0 0%	—	—	—
Apical dots	172	7 4.07	38 22.09	127 73.84%	—	—	—	—
Flatness of fruit	172	50 29.08	81 47.09	39 22.67	2 1.16	0 0%	—	—
Smoothness of fruit	172	14 8.19	51 29.65	96 55.81	5 2.91	6 3.49%	—	—
Thinness of rind	170	61 35.88	30 17.65	38 22.35	31 18.23	10 5.88%	—	—
Thinness of segment wall	170	102 60.00	43 25.29	23 13.55	2 1.18	0 0%	—	—
Color of pulp	170	106 62.35	56 32.94	8 4.71	0 0	0 0%	—	—
Size of central column	170	38 22.35	74 43.53	58 34.12	0 0	0 0%	—	—
Quantity of pith	170	0 0	4 2.35	151 88.82	14 8.24	1 0.59%	—	—
Quality of pulp	169	52 18.93	80 47.34	49 29.99	8 4.73	0 0%	—	—

Girth	Height	D/H Index	Wt.	Calyx	Navel	Areola	No. Segm'ts.	Rind	Center	Seedy frs.
20.20 cm.	4.70 cm.	1.37	gm. 113.40	mm. 10.5	0	0	11.50	mm. 2.13	11. mm.	1

The tree is a typical Owari with large, broad, not crowded leaves. Fruits are large, flat, well colored with large calyx lobes. Plant bought from the Glen St. Mary Nurseries.

### IKEDA VARIETY IN ALABAMA

The Ikeda variety is in existence in Alabama but the source of introduction is unknown. Through field observation, the difference is made clear by the habit of the tree and the characters of the fruits. Most of the Ikeda trees are smaller in size than the Owari of the same age, and have more abundant branches of a smaller size. Leaves are also smaller and more crowded, often making an uneven growth tending to cause twisting in shape. Normal leaves are narrower and more acutely narrowed at ends than those of the Owari. Fruits are smaller and more globose in appearance, and slightly later in maturing than the Owari. There were several individual trees used for investigation, which are described below :

Lot No. 85 of 1921. Ikeda tree of A. D. DAVIS, Irvington, Mobile County, Alabama. A tree in the 3rd row from the east, 4th tree from the south ; distance between rows, 5.76 m., distance between trees, 3.03 m. It has an E-W spread of 2.62 m., N-S spread of 2.88 m., and height of 1.89 m. A cut-back tree with five major branches arising almost from the ground. Branches abundant, leaves small, straight, sharp-pointed, crowded with short internodes, somewhat larger in the inside of the tree but not broad nor undulate, summer growth more or less mottled. Measurements of fruits are given in Table 92.\*

The average fruit is small, about ten fruits are large and rough and they are rather distinctly marked from normal fruits, being apparently terminal, late-bloom fruits. Average fruits round, especially round at the

\* PL. XX, Fig. 4

TABLE 92.

MEASUREMENT OF FRUITS FROM DAVIS'S IKEDA PLANT AT IRVINGTON,  
ALABAMA. LOT NO. 85 OF 1931. TOTAL NUMBER OF  
FRUITS, 130 (NOS. 6549-6676).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.05 cm.	4.51 cm.	1.34	89.32 gm	8.08 mm.	10.60	2.25 mm.	12.81 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	130	—	—	—	—	—	7	5.39
Sinuate based fruits	130	—	—	—	—	—	31	23.85
Semi-sinuate based fruits	130	—	—	—	—	—	55	42.31
Areolated fruits	130	—	—	—	—	—	6	4.61
Frs. with undeveloped calyx lobes	129	—	—	—	—	—	77	59.69
Frs. with long narrow calyx lobes	129	—	—	—	—	—	0	0
Fruits containing seeds	130	—	—	—	—	—	16	12.70
Apical depression	130	5 3.85	44 33.85	78 60.00	3 2.31%	—	—	—
Apical dots	130	1 0.77	35 26.92	94 72.31%	—	—	—	—
Flatness of fruit	130	15 11.54	41 31.54	52 40.00	16 12.31	6 4.61%	—	—
Smoothness of fruit	130	22 16.92	61 46.92	38 29.23	9 6.92	0 0%	—	—
Thinness of rind	126	99 78.57	18 14.29	6 4.76	3 2.38	0 0%	—	—
Thinness of segment wall	126	103 81.75	19 15.08	3 2.38	1 0.79	0 0%	—	—
Color of pulp	126	47 37.30	48 38.10	31 24.60	0 0	0 0%	—	—
Size of central column	126	1 0.79	11 8.73	55 43.65	47 37.30	12 9.52%	—	—
Quantity of pith	125	0 0	0 0	68 54.40	44 35.20	12 10.40%	—	—
Quality of pulp	126	9 7.14	36 28.58	66 52.38	15 11.90	0 0%	—	—

shoulder, stem-end conspicuously raised, not forming any flat area around the calyx. Apex slightly depressed, no conspicuous areola or navel, oil cell dots reach stylar point. Calyx considerably small, lobes very definitely undeveloped, body often rather elevated, the depression around the calyx broadly sinuate, with a few exceptions having rather small number of narrow-sinuate base. The disk is not strongly pressed in, and the demarcation with the rind is often faint. The color of fruits rather light, rind smooth, easily drying up. In the cross-section, rind thin, segment wall also thin, central column medium or small, with small amount of pith. Pulp rather light-colored, juicy but inferior in quality, mostly insipid. The fruit is rather more delicate looking than the ordinary Ikeda, but the essential characters are all typical of this variety.

Lot No. 86 of 1921. DAVIS's Ikeda plant. One of the original trees from which most of the budwoods were supplied. Two plants are in existence, both being introduced from the Monticello Nurseries of Florida. Samples picked from a single branch. Measurements are given in Table 93.

The fruit is still more round than the preceding, and has more typical sinuate base, but the calyx lobes are almost normal. The rind is thin but segment wall thicker, central column smaller and larger amount of pith. Pulp light-colored and very inferior in quality.

In DAVIS's orchard, a small tree with a limb variation bearing all naveled fruits, was found. The normal branch of this plant was typical Ikeda, with fruits not developing a navel mark. Total fruits of both branches were studied, and are tabulated below:

Lot No. 87 of 1921. Fruits all naveled, from a definite branch of a small tree of Ikeda in DAVIS's orchard. 7 fruits (Nos. 6403-6409).

Lot No. 88 of 1921. Fruits without navel, from another branch of the same tree. 3 fruits (Nos. 6410-6411, 6413).

	Girth	Diam.	D/H index	Calyx	Navel	Areola	Rind	Center	Seedy frs.
	cm.	cm.		mm.			mm.	mm.	
Lot 87	20.71	4.63	1.42	10.71	7(100%)	1(14.29%)	2.71	13.36	0
Lot 88	17.63	4.13	1.36	9.00	0	0	2.17	10.33	1(33.33%)

TABLE 93.

MEASUREMENT OF FRUITS FROM THE OLDEST IKEDA TREE IN DAVIS'S  
ORCHARD AT IRVINGTON, ALABAMA. LOT NO. 86 OF 1921.

TOTAL NUMBER OF FRUITS, 13 (NOS. 6391-6402).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.05 cm.	4.92 cm.	1.34	—	9.23 mm.	10.91	2.26 mm.	12.13 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	13	—	—	—	—	—	0	% 0
Sinuate based fruits	13	—	—	—	—	—	13	100.00
Semi-sinuate based fruits	13	—	—	—	—	—	0	0
Areolated fruits	11	—	—	—	—	—	4	36.36
Frs. with undeveloped calyx lobes	13	—	—	—	—	—	1	7.69
Frs. with long narrow calyx lobes	13	—	—	—	—	—	0	0
Fruits containing seeds	13	—	—	—	—	—	9	69.23
Apical depression	11	0 0	2 18.18	6 54.55	3 27.27%	—	—	—
Apical dots	11	1 9.09	3 27.27	7 63.64%	—	—	—	—
Flatness of fruit		(not measured)						
Smoothness of fruit	13	2 15.38	11 84.62	0 0	0 0	0 0%	—	—
Thinness of rind	13	13 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	13	2 15.38	7 53.85	4 30.77	0 0	0 0%	—	—
Color of pulp	13	0 0	2 15.38	9 69.23	2 15.38	0 0%	—	—
Size of central column	13	0 0	0 0	3 23.08	7 53.85	3 23.08%	—	—
Quantity of pith	13	0 0	4 30.77	9 69.23	0 0	0 0%	—	—
Quality of pulp	13	0 0	1 7.69	6 46.15	2 15.38	4 30.77%	—	—

The fruit of lot No. 87 is rather irregular in outline, base gradually broad, depressed, calyx large, and the section recembling Owari. On the contrary, the fruit of Lot No. 88 is round, regular in outline, and the section is typical of Ikeda. It is a rather remarkable fact that the Owari-like fruits were borne on a definite limb of an Ikeda plant, suggesting a nature of limb variation. It is of course premature to suggest that the former is originated by a limb variation, like this example, because we have not sufficient material to prove this assumption.

The above given examples of Ikeda fruits are sufficient to conclude that the variety difference of the Owari and Ikeda is distinct enough, as it is in Japan. Although the climatic and edaphic conditions of the Gulf States are rather widely different from those of Japan, the difference of varietal characters in the Satsuma orange is definitely established without appreciable modification. This fact was clearly noticed during the survey of 1917 and 1918, but the individuality investigations endorsed the validity of previous observations. The local regulation for variety segregation of the Satsuma orange in the Gulf States was first inaugurated on this basis, and then was withdrawn when everybody could quite easily distinguish varieties without any regulation or identification by the authorities.

### MISCELLANEOUS OBSERVATIONS IN THE GULF STATES, WITH SPECIAL REFERENCE TO VARIATIONS

During the course of field observations made in the Gulf States in winter of 1921, particular attention was called to the problem of variation in the Satsuma orange. No bud mutation originating Wase characters was found, but a case of willow-leaf variation was noticed in BASSET's orchard at Crichton, Mobile County, Alabama. This was found in an orchard in trees planted in one group. Subsequent notes on these trees were taken and are briefly as follows.

#### *Willow-leaf Satsumas*

The first tree (PL. XLVIII, Fig. 12.) 3rd row, 2nd tree from N-W corner. Plant 7 years after being set in 1916. Trifoliate stock raised



about 15 cm. from the ground. Trunk 25 cm. high, 20 cm. in girth, branching into 4 major branches spreading with rather narrow angles. Two eastern branches (B and C) thin but older, two western (A and D) thicker but younger. The leaves are all willow-like, except in the thickest N-W branch (branch B), the reversion to the normal being started from a point about 50 cm. from the union. This normal branch again shows willow character on the leaves of the early spring growth of certain branches, suggesting that the willow character is not entirely lost in this part of the plant. Other branches generally have very pronounced willow characters in their leaves, but still the following cases of reversion were noticed :

(1) Branch A. A summer growth 115 cm. long arising from a point 120 cm. from the union, showing normal character. Three other top growths shorter than the above also showing reversion.

(2) Branch B. One shoot 1 m. long, arising at 88 cm. from the ground, showing normal character.

(3) Branch C. One very upright shoot 80 cm. long at a point 140 cm. from ground, is normal. Two top growths of shorter length also normal. 5 or 6 leaves on the lower part are large and not willow-like.

A trace of contortion was noticed on the lower part of the branches A and D, resembling the twisting which is occasionally found in Wase sport branches in Japan.

The second tree. 2nd eastern row, 16th tree. It is a small tree which had once been cut back and is now appearing almost normal, but willow leaves are scattered here and there on every branch. Branches rather straight and not drooping.

The third tree. A big tree, indefinite semi-willow in nature. In east 7th row, 9th tree. The girth of trunk 40 cm. above the union, with 5 large major branches. It has an E-W spread of 4.04 m., N-S spread of 3.46 m., and height of 2.62 m. Leaves very green, short and somewhat like willow-leaf but the character lacks definiteness. Branch characters normal, straight, not drooping, spreading. Shoots rather thin, internodes short. Pocket leaves are normal.

These trees were not bearing, but a few fruits found on the trees were picked and measured, the figures being tabulated below :

Lot No. 92 of 1921. Three fruits from the first tree (Nos. 6382-6384). Small-sized, round, calyx very small, lobes not developed, and navel entirely lacking. Rind medium in thickness, segment wall medium-thin, central column extremely small, rather abundant quantity of pith. Number of segments many. Pulp medium deep-colored and fairly good quality better than expected.

Lot No. 93 of 1921. Two fruits from the second tree (Nos. 6385-6386). Picked from normal branch. Size normal, round, looking exactly like the Ikeda, but not so tall as above. Calyx slightly larger, navel not developed. In cross-section, rind medium, segment wall thin, central column small, medium amount of pith. Number of segments few. Pulp deep-colored and of fair quality.

Lot No. 94 of 1921. Four fruits from the third indefinitely semi-willow tree. Small-sized, round, calyx slightly larger, lobes being nearly normal. Navel not developed. Rind medium in thickness, segment wall medium-thin, central column small with medium amount of pith. Number of segments few. Pulp light-colored and only fair in quality.

These lots of fruits have a similar character of base identical with the Ikeda variety, so that the variation seems to exist within the Ikeda, as is the case in the willow-leaf Satsumas from Japan already described in the previous chapter.

The measurements of these fruits are as follows :

	Girth	Height	D/H index	Calyx	Navel	Areola	No. segm.	Rind	Center	Seedy frs.
	cm.	cm.		mm.				mm.	mm.	
Lot 92	16.33	4.30	1.19	8.67	0	0	11.67	2.33	7.67	1(33%)
Lot 93	18.35	4.55	1.28	9.00	0	0	10.00	2.75	9.25	1(50%)
Lot 94	16.20	4.10	1.25	9.25	0	0	10.00	2.50	8.63	2(50%)

The difference between the normal and the willow fruits is exactly the same as was discovered in Japan. The willow fruits are globose, much taller in outline than normal fruits, and the central column is very small, with an abundant quantity of pith. The rind is also conspicuously

thicker in comparison with the size of the fruits. It is also noticed that these fruits on the willow parts mature later than those on the normal parts.

### *Thorny Owari Satsuma*

The thorn-bearing character in the first year of growth after being budded, or the occasional development of thorns on the luxuriant summer growth of the Owari tree is a fact very frequently observed in Japan and in the United States. Extremely thorny plants are, however, very rare in these countries though not absolutely impossible to find. A cut-back tree of thorny Owari was found in BASSET's orchard. A brief description of this plant is given below :

Lot No. 95 of 1921. Thorny Owari tree in Alabama. East 2nd row, 12th tree in BASSET's orchard. The plant had been cut back to the ground, as it was extremely thorny and it was undesirable to keep it alive. The shoots which sprang up from the cut surface grew for two years, showing exactly the same thorny character. The second year growth is very upright, 1.60 m. long, having very large formidable thorns. The first year's growth is low, bushy, being more or less thorny but not very strongly armed. The thorns are all strong and persistent, the longest being 6.5 cm. long, located at a point about 0.58 m. from the cut-back surface. Many other thorns are also longer than 5 cm. in length. .

The leaves of this plant are rather large, light-colored, and some of them are conspicuously broad, as in normal Owari. No fruit was found on the tree.

### *Twisted leaved Satsuma*

A peculiar leaved plant of Satsuma orange was found at the POTTER tract, in Grand Bay, Alabama ; the leaves were short and twisted, like those of the unproductive Ikeda tree in the Hôkwaen orchard near Kago-shima, Japan (Lot No. 20 of 1919). The plant was large-sized, having large upright branches very much elongated. The fruit (Lot No. 96 of

1921, 7 fruits, Nos. 6375-6381), looked round, smooth-skinned, oil cells showing flowing structure (becoming streak-like) at the stem-end, calyx not large, with prominent disk ring. The fruits borne were only a few, but it is said that the tree had a good crop before. The fruits remaining on the tree were greenish and rather unripe. The measurements are given below :

Girth	Height	D/H Index	Calyx	Navel	Areola	No. Segm'ts.	Rind	Center	Seedy frs.
17.67 cm.	4.39 cm.	1.28	mm. 8.86	0	0	11.71	2.00 mm.	8.90 mm.	3(42.86%)

The fruit has thin rind, central column is small, number of segments many, and rather good quality of pulp. This is an individual exactly similar to the Japanese plant mentioned above. The origin of this kind of individual is quite unknown. Future study may show whether this is a retrogressive mutant of the Owari or the Ikeda variety, or a temporary variation due to certain environmental and physiological factors, like soil conditions.

#### *Ikeda plant on Sour stock*

An Ikeda tree on sour stock was found in HILCHER's orchard at Foley, Alabama, the character of which was investigated. It is briefly described as follows :

Lot No. 89 of 1921. A tree of moderate size, very bushy in habit, branches being extremely upright in growth, abundantly shooting. Leaves small, crowded, and narrow, and only a small percentage of the leaves are normal. The fruits (3 in total, Nos. 6366-6369) are round in appearance, without navel and areola. Fruit base is all sinuous and calyx small, lobes sometimes undeveloped. Measurements are as follows :

Girth	Height	D/H Index	Calyx	Navel	Areola	No. Segm'ts.	Rind	Center	Seedy frs.
17.60 cm.	4.30 cm.	1.30	mm. 8.75	0	0	10.25	2.17 mm.	6.50 mm.	3(100%)

The rind is thicker and segment wall also thicker than normal, central column very small and pith very abundant. Pulp deep-colored and fairly good quality. The plant is very unproductive, but the fruit is rather normal and not deteriorated, in spite of the great difference of the character of the tree. It is said that there is another tree (Owari variety) budded on the sour stock, but the writer was unable to locate the individual.

*Ikeda plant on Rusk stock*

In SHAW'S orchard, Alabama. Behavior of tree looked almost normal. Fruits measured as follows (Lot No. 90, 8 fruits, Nos. 9865-6872):

Girth	Height	D/H Index	Calyx	Navel	Areola	No. Segm'ts.	Rind	Centar	Seedy frs.
18.30 cm.	4.56 cm.	1.27	mm. 8.00	0	0	10.88	2.34 mm.	mm. 11.94	8(100 %)

The fruits are deep-colored, normal in pitting and apical depression. Rind is thin but segment wall very thick, central column small with abundant quantity of pith. Pulp medium-deep in color, acid in flavor. It is rather disappointing that the fruits on Rusk stock have such high acidity, though the rind is good in color. Thick segment wall and much pith at the center are also objectionable characters. Further study is necessary to find out if these characters are definitely associated with the difference of the rootstock or not.

*Appendix: Owari Satsuma grown in California*

Seven fruits (Nos. 7053-7059) of Owari Satsuma fruits were received for study on May 25, 1922, from the CLARK Ranch, Churra Vista, California.\* The fruit has an appearance of fairly good size, flat outline, large calyx, pitted surface, and deeply depressed apex. Naveled fruits were frequent and areola often present. The color is not intense but some of the fruit are good in color. The measurements are as follows:

\* PL. XX, Fig. 3.

Girth	Height	D/H Index	Wt.	Calyx	Navel	Areola	No. Segm'ts.	Rind	Center	Seedy frs.
cm. 20.03	4.51 cm.	1.41	gm. 73.86	mm 9.33	3 (42.86%)	5 (71.43%)	11.86	mm. 5.75	mm. 17.57	3 (42.86%)

The fruit has extremely thick rind, moderately thick segment wall, extremely large central column, and rather abundant pith. Pulp medium-deep in color, extremely discolored, and nearly drying up. A few juicy fruit have medium-good quality. It is very interesting to note that the Owari Satsuma fruit produced under arid conditions has nearly normal size and shape, but the rind becomes considerably thick and the central column becomes very large, or in other words, the growth of rind is very much greater than that of the segments. Further study is necessary to determine if such is the average fluctuation of the character of the fruit of the Satsuma orange grown under extremely dry conditions.



## **BOOK V**





# STUDIES IN THE KAWANO WASE VARIETY OF THE SATSUMA ORANGE, WITH PARTICULAR ATTENTION TO ITS VARIABILITY

## DISCOVERY OF THE WASE SATSUMA FOR ECONOMIC PLANTING

The plant bearing an enormous crop of extremely early maturing fruit is known commercially in Japan as the *Wase Unshû*. The fruit filling the markets of the large cities in the early part of October comes from Ôchô-mura, Toyoda-gun, Hiroshima-ken and Tsukumi-mura, Kita-amabe-gun, Ôita-ken. Until about 1910, there were no such Satsuma fruits coming to the market so early in the year, but now-a-days the total crop of the Wase Satsuma is estimated to be worth about 500,000 yen every year. This wonderful achievement, reached in such a short time, is worth thorough examination, and an extensive study has been carried out by the writer since 1919. Repeated visits to both Hiroshima and Ôita Prefectures revealed the whole truth of such a rapid gain in popularity of this particular Satsuma, and the writer wrote in a paper every detail which affects its history and character<sup>(69)</sup>. A brief history of this interesting variety is reviewed in the following paragraphs. It is to be noted that this is not a mere compilation of one-sided stories found in many Japanese journals, but was written very carefully after investigating the true situation through the men who were responsible for the present development of the Wase Satsuma industry.

MATSUMOTO<sup>(69)</sup> correctly attributed the honor of the discovery of the Wase Satsuma to the efforts of Katsuzô MIYAZAKI of Tsukumi village in Kitaamabe-gun, Ôita-ken. The author obtained much valuable information from him about the early propagation of this variety, and after his death the author's appreciation was engraved on the monument stone erected in honor of this first pioneer of Wase planting. Equal honor should be given to Tadaichi ISHIDA, who first introduced this variety into Ôchô, in Hiroshima-ken. The real industry has developed under his

enthusiastic encouragement. Valuable information was also obtained from him before his death, and the history of the distribution of the variety mentioned below is largely based upon his conversation.

### A FARMER'S FINDING OF EARLY MATURING SATSUMA TREES

The original Wase Satsuma plants exist in the orchard of Nakaji KAWANO at Aoe-mura, Kitaamabe-gun, Ôita Prefecture. Mr. KAWANO, a mat-maker of the village, first noticed that some of his plants bore early maturing fruits every year. There are four plants, grafted on trifoliate stocks, still bearing a crop regularly, identified as the Wase Satsuma, and three of them, as the mother trees, are responsible for the whole Wase industry. Mr. KAWANO brought a bunch of these novel fruits in 1894, to Utarô SUZUKI, a local packer, as a gift. This was the first step by which this orange became universally known.\*

In the same year, a similar bunch was given to Mr. Katsuzô MIYAZAKI, his nephew, as a gift for a local festival taking place on September 9th. Being anxious to fill up a few vacant spaces of his orchard rows with some good fruiting strain of the Satsuma plant, MIYAZAKI was delighted to see these fruits, thinking that this kind was most suitable for his place. In 1895, he was permitted to take bud sticks from three plants of KAWANO's orchard\*\*. Several large trifoliate plants, already set in his hill-top orchards at Kajiya and Furuyado were top-grafted with these scions. One of the Kajiya trees bore fruit in 1896, and most of other trees began to bear in the following year. This attempt attracted the attention of his friends and some progressive growers, like Ejurô SHIMOMURA, Sakutarô SAKAMURA, and Matsuji KUBOTA. The name "Wase Unshû" was first given by SHIMOMURA to MIYAZAKI's plants which were propagated under this name by these persons from MIYAZAKI's top-worked trees. MIYAZAKI made another introduction of KAWANO's bud-sticks in 1899, and he increased the second generation

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\* Information from Mr. Nakaji KAWANO himself.

\*\* The fourth plant was not known at this time.

trees in his orchards. KAWANO himself followed MIYAZAKI in multiplying his Wase plants, and there are at present ten trees of second generation individuals in his Nidenoki orchard, propagated almost at the same time as MIYAZAKI'S.

The origin of KAWANO'S original plants is unknown. He opened this place, called Tabaru, in about 1870, and he planted partly trifoliate stocks and partly set out already grafted Satsuma plants bought from a nurseryman. The trifoliate plants were later top-worked with the scions taken from the local Satsuma plants, and he believes it possible that these Wase buds may have come from these plants grown in the vicinity, since these Wase plants are standing side by side in one row, except the fourth plant in the next row, suggesting that they were grafted at the same time with scions carried together in the same bundle. As early as 1910, the writer learned through Mr. Tadasu KAWANO, an intelligent villager of Aoe, of the existence of another large Wase plant in the same section of the village, the property of Ichigorô YAKUSHIJI. This plant was thoroughly examined from time to time by the writer, and he found that this is also a grafted tree living to be over 90 years old at present. This tree has never been intentionally propagated on a large scale, chiefly on account of the unwillingness of the owner to cut bud sticks. Whether KAWANO'S scion came from this plant or not, is impossible to tell. It is, therefore, treated as an entirely different strain. The origin of this huge Wase tree is also unknown. Detailed studies of these historical trees are given in a later part of this report.

In 1902, the village of Tsukumi was visited by Mr. Hachirô AKIMITSU, village master of Ôchô, and his friend Keizô ÔSHIMO, a member of the village council, and they learned from Utarô SUZUKI about KAWANO'S plants bearing early maturing fruits. They visited the mat-maker's trees and soon recognized the economic value of this kind of tree from the standpoint of the rapidly growing business activity of their village, based upon the Satsuma orange. After returning to their own village, supporters of their view, mostly members of the Kyôshinkwai promoting club, resolved to send a man to get bud sticks from these Wase trees, and Mr. Tadaichi ISHIDA was chosen to accomplish this mission. When he visited Aoe, he

was warmly welcomed by the mat-maker and was permitted to take bud-sticks himself. He found, however, that the plants had overborne in the preceding year and there was not enough budwood left on the trees. He asked Mr. KAWANO if there were anybody else propagating this type and he learned that MIYAZAKI has some plants. He went to TSUKUMI and obtained additional bud sticks, taken by MIYAZAKI from his orchard. The whole bud sticks, unfortunately all mixed together in one bundle, were taken home by ISHIDA, and were divided up into many small portions and given to the persons who took part in paying the expense needed for this expedition. The grafted plants multiplied very rapidly, and a good many trees were found bearing when the writer first visited Ôchô village in 1910.

### HORTICULTURISTS' RECOGNITION OF THE WASE SATSUMA

In the winter of 1910, the writer visited both the Aoe-Tsukumi region and Ôchô village. Eight year old Wase trees were investigated at the latter place, mostly in Mr. AKIMITSU's orchard. The oldest Wase plant at Aoe, owned by Ichigorô YAKUSHIJI, was then noticed as "a tree of hemispherical shape, more or less upright habit, with upright and light-colored leaves crowded with short internodes"\* . This plant was later studied by TAKAHASHI<sup>(135)</sup> and the measurements were given as follows: Girth of one of the two main trunks divided at 15 cm. from the ground, 49 cm. ; height of the tree 3.5 m. ; diameter of the tree 5.23 m. He states that besides this plant there had existed a similar one in the orchard owned by Ichigorô YAKUSHIJI, but it had died before his examination. He roughly estimated the living plant to be aged about 80 years, 10 years older than the author's estimation. He also admits that Nakaji KAWANO's plants came from this plant, but he does not mention whether this statement is based only upon his speculation or not. None of the staff of the Horticultural Substation of the Imperial Agricultural Experiment Station at Okitsu knew about this particular early-maturing Satsuma, and

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\* From a note by the author taken in the field in 1910.

in conversation with Prof. ONDA, the director, the writer recommended him to try this interesting kind at the station. This recommendation, made in 1910 by the writer, was approved, and the station wrote to the addresses given by the writer for bud sticks and grafted plants. In response to this request, both Tadasu KAWANO and Hachirô AKIMITSU supplied materials, and this variety was definitely established at the station.\* In 1911, many specimens of fruit were received and studied by the writer, as stated before. He gave a talk with a display of the specimens at a seminary held in the Tokyo Imperial University. In 1912, the writer<sup>(138)</sup> definitely said, "Wase Unshû (forma *præcox*), which I recommended to the government, is really worth testing on a large scale", and, "In prefectures like Kanagawa, where planting of an early kind is required on account of the facility of shipping fruits to the Tokyo market, the Wase Unshû is the one best fitted."

Despite the author's enthusiastic recommendation, there were some misleading conceptions prevailing around Okitsu about the nature of the Wase Satsuma, discrediting its early maturity and exaggerating the insipidness of the pulp tested at the wrong time of the season.\*\* Unwarranted rumor then prevailed among the growers that the Wase is not worth while for planting, notwithstanding the fact that ONDA and

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\* SATO, in Journ. Hort. Soc. Japan vol. 36 no. 6. p. 35, states that KAWANO's plants were received at Okitsu in 1911. and others came in the next year. There are several top-worked trees at Okitsu which were propagated at this time.

\*\* The editor of Kwaju (Fruit Trees) states under the heading "Zenkoku Unshû Mikan no Hinshitsu" in l. c. no. 107, pp. 38-40, 1912, that the Wase fruit sent from Ôita and Hiroshima appeared beautiful but the judges of these fruits admitted that they were most inferior in quality.

This refers to the study we carried on at Okitsu in 1911, and the judges (Messrs TANIKAWA, MATSUDAIRA and the author) never expressed such an opinion to an interviewer from any magazine. Prof. ONDA, the director of the Okitsu Station, clearly stated "the quality of Wase was reported from the people of its producing provinces as most palatable, but when we tested them at the period between December 5th. and 13th., the flavor was almost lost and was insipid." (from a paragraph of his speech delivered at the Second National Convention of Citrus Growers' Associations, held at Wakayama in April, 1912.) See TAKAHASHI, l. c. p. 14. This, however, does not mean the inferiority of the quality of Wase Satsuma. The statement of the Kwaju is therefore baseless, and no authentic announcement was ever made that the Wase is worthless for planting. It is also unthinkable that such a statement is responsible for the slow development of the Wase industry in this region.

UCHIDA<sup>(92)</sup> strongly recommended the planting of Wase trees up to  $\frac{1}{3}$  or  $\frac{1}{4}$  of the total area of the orchard which the farmers devoted to ordinary Satsumas. ONDA<sup>(91)</sup> later stated, "The Wase Unshû accidentally found at Tsukumi in Ôita-ken is planted in various places now-a-days, and it looks to be a new variety originated from the ordinary Satsuma: The fruit matures about 14-15 days earlier and is significant from the orchardists' standpoint in this respect."

ABE<sup>(1)</sup>, a contemporary horticulturist, gives his view about the Wase Satsuma as follows:

"Wase fruit ripens at least one month earlier than others: The best season for picking is the middle of October. The fruit is valued at one sen apiece wholesale, if the fruit is picked at the end of September. It is possible to plant 200 trees in one acre of ground, since the tree is dwarf, but stunted growth is disadvantageous for the taking of budwood from the tree, unless the tree is forced by the application of an excess of fertilizers. The fruit of Wase is beautifully polished, having smooth oil cell dots. It starts bearing in the third year after it is grafted, but occasionally fruits are borne in the second winter. The branches look thin but are densely leaved, looking something like an apple, bearing fruit at the end of the branches in clusters."

ABE also states that the nursery plants of Wase have (1) thick and rather short spring wood; (2) small and tufted leaves; and (3) are generally light-colored and have blunt tipped blades. He also noticed that the sprouting of the spring shoot comes earlier than in other Satsumas, its wood is coarsely striated, the internode is much shortened, and small, short branches are produced at the lower part of the tree. The nursery plant is also stated to have a considerably side spreading habit.

HIRANO<sup>(40)</sup> is perhaps the first horticulturist who gave a description of the Wase Satsuma. His description is as follows:

"Tree mostly dwarf, spreading sidewise, branches short, with shortened internodes, springing up in fascicles especially from shady pocket part; flowers appear also in a dense cluster. Leaves small, tufted, commonly with rounded apex, surface smooth but lacking lustre, thin and light-

colored. Fruit oblate or depressed globose, concave at both ends, small in size\* ; oil cell dots dense, surface smooth, texture fine, said to have soft segment wall. Ready to be picked from the beginning of September, but usually picked at the middle of October, being at least ten or fifteen days earlier than others.

### CHARACTERS OF THE WASE SATSUMA

The following description of the Wase Satsuma was given by the writer in 1921<sup>(69)</sup> after a comprehensive study made in the field during 1919 and 1921.

“Many interesting features besides the early coloring nature can be noticed by close examination of the Wase fruit. The perfect smoothness and the turgid look of the skin associated with even, not up-and-down, oil cell dots, are distinctly noticeable in early October, when other varieties bear green, pitted fruits. At this time, the fruit of Wase already starts coloring from the blossom-end or from the side, and this makes it very easily distinguishable from the fruit of other kinds. Full-grown fruits of the Wase are large-sized, roundish, more or less conical or flattened, and in the latter case the flatness is symmetrical, making no difference in the lateral view whether the fruit is placed stem-end up, or upside down. The depression of both stem-end and blossom-end is not of any significance, and the crater-like concavity of the stem-end can be seen only exceptionally in late-bloom fruits. On the contrary, the area around the calyx is noticeably flat, often more deeply colored than the other parts, and is occasionally provided with fine radiating streaks of oil cells. The calyx of the fruits is considerably large, the disk underneath being also large and flat, usually leaving no definite demarcation between the surrounding part of the skin and the disk itself. Around the calyx a sharp

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\* The fruit of Wase is not small, unless the tree bears too heavily. HIRANO also quotes the growers' opinion that the crop of Wase is about 70 percent of an average yield of other varieties. This may be true when the tree is not satisfactorily fertilized, but the tree is generally more productive when fed well.



circular groove is often present at a distance quite far from the disk circle. Such a circular groove is not infrequently seen in the fruit of Ikiriki, but the former is noticeably broad in diameter and does not come so close to the calyx. The depression of the blossom-end is also little, and whenever there exists any areola, it is not so prominent as that of the Ikeda fruit. Moreover, the area inside of the areola or the space near the styler point is, in the majority of cases, naked looking, lacking the dots of oil cells.

"In halving the fruit, it can be noticed that the rind is considerably thin and the central column is small. The outside wall of the segments is adherent to the peel, especially during the months of October and November. The walls themselves are very thin and also adherent to each other; often a break is caused in the attempting to separate the segments with the fingers. The pulp is comparatively meaty and less acid. When observed closely, the pulp vesicles are considerably larger than any other kinds and are interwoven in a salmon-flesh structure. No seed is contained unless there is some seedy variety planted in the neighbourhood.

"With these characteristics above described, the Wase can hardly be mistaken for any other variety, there being by no means a rival, even in the single character of early maturity."

As to the peculiarity of the Wase variety, the writer further stated as follows:

"It is necessary to bear in mind that the fruit characters are often greatly changed by the phenomenon of fluctuation which may bring the fruit characters near those of the Owari. Similarly the characters of the Owari may approach those of the Wase, and it will be found insufficient to use the fruit characters alone for identification whenever the observer makes the study with clearness and accuracy. Speaking of the size of the fruit, it may possibly be reduced in a year of overbearing, or by age or malnutrition. Likewise, the other characters, such as the great smoothness of the skin, the large size of the calyx, or the round outline (without depression at both ends) in the side view, are merely references for rough classification. Consequently, it is necessary to depend upon other peculiarities of the vegetative organs to make a close distinction from other

kinds. It is fortunate that the Wase differs greatly from others also in this respect.

"The Wase is at any rate a dwarf variety. The growth of bearing shoots is comparatively slow, and the length between the nodes is short. Accordingly, the growth of the leaf is stunted, which makes sidewise expansion much greater than terminal elongation, thus as a consequence, the shape of leaves is more lozenge than lanceolate. In other words, leaves tend to assume an angular shape as the result of considerable side expansion, and sharp tapering at both ends. The unequalness of the growth of the leaf blade often gives a twist to the whole lamina.

"The appearance of the tree is rather side-spreading, instead of upright. Branches and leaves are many, often with drooping shoots, and these characters, together with smaller twisted leaves, are seldom seen in other varieties. The only similarity to these, if it is necessary to mention it, is seen rarely in such a case as the "Kogakei" (a Zairai variety from Koga, Nagasaki-ken) grown under an over-fertilized condition in the rich soil of the Nogawachi and the Yamagawachi sections of the village of Ikiriki. Under close observation, the leaves of the Wase will be noticed to have a paler color and a thicker texture, but the very frequent infection of red spider tends to bleach the color more conspicuously than ordinarily.

"There are still greater differences in the large sized dormant buds and their increased number at each node. This can be easily detected with the aid of a lens. Taking the fifth bud from the terminal, for instance, of both Owari and Wase shoots, it will be seen that there are three aggregate buds at one axile in the Wase, but only two in the Owari. To correspond with the increased number in the bud group, the petiole of Wase lying under the bud is naturally bent outward at the base, and also the wood is driven back to give enough room for the bud. Consequently, the shoot of the Wase has its internodes breaking alternately in other directions at each node in a zigzag way ("flexilis" in Latin), and this character presents a strong basis in favor of the variety, if a strong shoot of an other variety is brought for comparison. As a natural result of the increase of the number of buds, the flowers of Wase are more numerous

than other varieties. The flower bud, just before its expansion, is considerably large-sized, and is swollen outward at the middle part, giving a somewhat different appearance from the flower buds of ordinary Satsumas. The calyx tube of the Satsuma flower is generally cup-shaped before the expansion of the bud, and then opens flat in the shape of a plate during the blooming time, like that of the Yatsushiro. It looks almost flat from the beginning in the Wase flower. After all, the nature of the Wase Satsuma to bear heavily in grape-like bunches, is not due to the formation of a many-flowered peduncle, as in the case of the grapefruit, but is due to the increased number of flower buds at each axil. The heavy bearing character of the Wase is therefore a natural morphological character, and not a temporary nature caused by external influence."

As to the superiority of the Wase Satsuma, the writer concluded as follows :

"The early ripening and heavy bearing of the fruit are unquestionably the most superior characters of the Wase Satsuma which suffer no competition from other varieties. Moreover, when the tree is young and is grown under proper conditions, the fruit will be very large, beautifully smooth, thin-peeled, small-cored, and the pulp well filled up and less acidic than in others. These desirable characters of Wase are undoubtedly placing the variety in a high rank among Citrus fruits, and whatever discount may be made to this judgement, the value of the Wase as merchandise will not be altered to its disadvantage. The fruits are sold at about 7.50 yen per box, while others hardly bring 3.50 yen, and the fruit is sold at fruit stores for as high as 15 sen apiece."

As to the drawbacks in connection with Wase culture, the writer also pointed out its slow growth requiring heavy fertilization ; its susceptibility to red-spider and rust mite, requiring frequent lime-sulphur sprays ; its weakness towards a particular disease, the black rot of fruit caused by *Gloeosporium foliicolum* NISHIDA, necessitating applications of Bordeaux spray ; its thin skin which is easily smashed by a light pressure, and requires careful packing and shipping ; the need of a large market nearby, since it is an early variety and cannot afford any delay in consumption ;

and its variability, which makes its propagation extremely hazardous. The last question, variability, is discussed in later chapters.

## DETAILED STUDIES IN ORIGINAL WASE SATSUMA PLANTS

Since 1919, repeated studies of the plants of Nakaji KAWANO and Ichigorô YAKUSHIJI, of the Wase Satsuma were carried out by the writer, and the descriptions of these plants are summarized as follows :

### (1) Description of the tree of Kawano Wase.

Four plants located in the orchard of Tomitarô Kawano, the son of Nakaji KAWANO, mat-maker, at Tabaru, Kuratomi, Aoe-mura, Kitaamabegun, Ôita-ken. Site of the orchard :—A slope inclined toward E-E-S, a terrace irregular in breadth. Location of the trees :—No. 1 tree (PL. XLVIII, Fig. 14) is in the top row along the path, being the fourth tree from the north end of the row ; No. 2 tree (PL. XLVIII, Fig. 13 and 14) is the next one to the above on the north side ; No. 3 tree (PL. XLIX, Fig. 1) is on the next terrace row below (east), a little farther north, on one side of a big rock ; No. 4 tree (PL. XLIX, Fig. 2) is next to the above on the south, being unknown in early days (until 1924) but is considered to be one of the original trees. The distance between trees planted in this orchard plot ranges from 1.74 to 2.33 m. and about 2.62 m. at the lower rows, generally being crowded. Size and shape of the trees : No. 1 tree is on elevated trifoliate stock, being a more or less upright, single-stemmed tree, with three branches arising at a point about 15 to 17 cm. from the union. It is 2.62 m. tall, southern branches are suppressed by a neighbouring tree. Diameter is about 2.62 m. Foliage denser than others, typical Wase. No. 2 tree is also on an elevated trifoliate root, girth at the union being 54 cm. (in 1920). The main trunk is forked into two at 17 cm. from the ground. Girth of trunk is 35 cm., and that of branch trunks is 29 cm. and 22 cm., respectively. It is 2.23 m. high and 2.33 m. in diameter, being a slender and an old looking tree with rather upright branches more or less zig-zag in habit. Leaves not many. No. 3 tree has the root stock buried under the ground, forks immediately at the ground level and both of the forked trunks

fork again, the western one being larger. It is a medium-sized tree about 2.62 m. high, E-W spread 2.03 m., N-S spread 2.62 m., and the branches mostly pointing toward the east on account of the slope, the narrow terrace and the pressure of the big stone on the western side. Branches loose, leaves rather deeper colored and broad; typical in general respect. No. 4 tree has the root stock concealed under the ground, trunk rather thick, forked into three large upright branch trunks. It is about 4.33 m. high and 3.46 m. in diameter, being better looking than the others (in 1924), leaves being deeper colored and more crowded. Branches more or less loose, but many small branches. Soil fertile, a loam very rich in organic matter, gravel lacking. Treatment of plants: mulched with grasses once in the spring; fertilization three times a year, consisting of 1 shô (1.82 litre) of Nishin (herring) cake and 4 kwan (15 kg.) of stable manure, per tree. Origin of bud: unknown. Orchard name: Wase (this name has been used for 20 years; up to 1920), or "Haya-mikan" (early orange). Propagation: Top-worked on trifoliate orange stock by Nakaji KAWANO. Picking season: After October 10th. Wholesale price: 3.50—3.90 yen per 6 kwan (22.5 kg.) in 1920.

(2) Description of the tree of Ichigorô YAKUSHJI.

Location: Kuratomi, Aoe-mura, Kitaamabe-gun, Ôita-ken. Site: On a slope dipping to S-W. Location of tree: A single tree of very large size, existing beyond the low hill ridge facing the valley (PL. XLIX, Fig. 4). Large tree with round head, more or less inclined toward S-W. Main trunk very short, girth 95 cm. at 4 cm. above the union; girth at the union 108 cm. Two main trunks at the bottom, large one having a girth of 55 cm., smaller one 50 cm. A low branch stretching toward the slope has a girth of 25 cm. Height of the tree is about 4.6 meter, spread about 6×6 meter. Leaves typically light-colored, broad and lozenge, somewhat twisted. Not regularly fertilized, heavily mulched with vegetable matter, and *Amorphophallus conjac* is planted under the tree. Average crop about 36 kwan (135 kg.) or less. Soil very rich. Origin unknown. Present owner: Kitarô YAKUSHJI, younger brother of Ichigorô YAKUSHJI. Crop is uniform without mixture of other types of fruits.

## PRELIMINARY TESTING OF FRUITS OF THE KAWANO WASE

In 1919, a fruit of one of the four trees of the Kawano Wase plants was obtained. This was picked by the owner Mr. Tomitarô KAWANO and given to the author on his visit on Nov. 2, 1919. The fruit was shaped typically depressed-globose, with beautifully colored skin and large oil cell dots. The base of the fruit was only slightly depressed, and the apex had no areola, a slightly opened navel being present. The halved fruit showed thin rind, thin segment wall, small central column, and medium amount of pith. The pulp was beautifully colored, good tasting, and slightly over-ripe. The measurements of the fruit are given as follows :

Girth	Diameter	Height	D/H Index	No. Segm'ts.	Rind	Center	Seed
19.5 cm.	6.0 cm.	4.6 cm.	1.30	10	mm. 1.5-2.0	13×10 mm.	0

### FRUIT TESTING OF KAWANO WASE (1)

In 1920, the entire crop of the No. 2 tree was studied statistically; the description of the material being as follows :

No. of fruits : 114 (Nos. 14-127). Total amount about 3 kwan (11.3 kg.). The size of fruit was medium (rather small for a Wase), shape round and slightly depressed. Rind very much polished ; stem-end much flattened or shallowly concave. Calyx large-sized, disk ring large, reaching beyond the end of calyx lobes. Navel not very prominent ; areola semi-distinct. Tightness of the skin remarkable. The rind was still greenish, being partly colored, and the condition of fruit was still unripe. Blemishes : surface scabby and an affection of rust mite and melanose frequent. Date of picking : October 14, 1920. The measurements of fruits are given in Table 94.\*

\* PL. XXI, Fig. 1.

**TABLE 94.**  
**MEASUREMENT OF FRUITS FROM THE ORIGINAL TREE NO. 2 OF THE**  
**KAWANO WASE AT AOE, OITA-KEN. LOT NO. 2 OF 1920. TOTAL**  
**NUMBER OF FRUITS, 114 (NOS. 14-127).**

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.45 cm.	4.43 cm.	1.33	82.08 gm.	10.12 mm.	10.79	1.72 mm.	10.79 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	114	—	—	—	—	—	35	30.70%
Sinuate based fruits	114	—	—	—	—	—	8	7.02
Semi-sinuate based fruits	114	—	—	—	—	—	4	3.51
Areolated fruits	113	—	—	—	—	—	60	53.10
Frs. with undeveloped calyx lobes	91	—	—	—	—	—	6	6.59
Frs. with long narrow calyx lobes	91	—	—	—	—	—	9	9.89
Fruits containing seeds	114	—	—	—	—	—	7	6.14
Apical depression	112	0 0	51 45.54	59 52.68	2 1.79%	—	—	—
Apical dots	109	33 30.28	55 50.46	21 19.27%	—	—	—	—
Flatness of fruit	114	16 14.04	48 42.11	45 39.47	4 3.51	1 0.88%	—	—
Smoothness of fruit	114	88 79.19	23 20.18	3 2.63	0 0	0 0%	—	—
Thinness of rind	114	104 91.23	8 7.02	1 0.88	1 0.88	0 0%	—	—
Thinness of segment wall	114	69 60.53	29 25.44	13 11.40	3 2.63	0 0%	—	—
Color of pulp	114	0 0	27 23.68	70 61.40	11 9.65	6 5.26%	—	—
Size of central column	114	0 0	2 1.75	53 46.49	38 33.33	21 18.42%	—	—
Quantity of pith	114	6 5.26	19 16.67	81 71.05	7 6.14	1 0.88%	—	—
Quality of pulp	114	0 0	2 1.75	18 15.79	37 32.46	57 50.00%	—	—

Owing to the severe infection of sour scab, the fruits were smaller than average size and were very late maturing. The tree is said to have been injured by fire in 1912, and since then the crop has been greatly reduced and the quality much inferior. The fruits were typical in having the smoothness of skin, the presence of a naked area around the stylar point, thinness of the rind, and smallness of the central column, but the color of rind and pulp was very much lighter than normal and the taste was very inferior. The amount of pith at the central column and the thickness of the central column were about normal. Areolated fruits were abundant, and navelled fruits were considerably few. 68 fruits were scabby, among which 18 were severely infected. Besides these, 22 fruits were rusty or russet. In conclusion, this lot is typical Wase, now commercially grown, although it is inferior in quality because of the poor condition of the tree.

### FRUIT TESTING OF KAWANO WASE (2)

In 1924, the second test of KAWANO's fruit was made, and the crops of all four trees were examined. Fruits were picked by Mr. KAWAI, county agent, and were sent to Fukuoka, arriving on the 28th of October. The following notes were immediately taken on their arrival.

The appearance of fruits poor, but seems to be slightly improved since last time. The plants are apparently neglected and the fruits are full of sour scab and rust mite, small-sized and not typical. Every lot was looking almost similar in color, shape, and size, also as to the infection of parasites. Range of size, large (not very large) to small, color a mixture of green and bright reddish orange, green fruits are more abundant in No. 2 tree lot, and bright-colored ones more in No. 1 tree lot. Shape almost uniformly medium-flat or medium, more or less rectangular, not many extra-flat or extra-tall ones. No. 4 tree lot is possibly flattest in appearance, No. 1 following, No. 2 next (more or less flat), and No. 3 tallest. Scabbiness is worst in the No. 2 tree lot; No. 1 bad in smaller half; top-worked part of No. 3 bad in larger fruits; infection throughout in No. 3 and No. 4 tree lots. Base of fruit usually



flat, occasionally with a double ring, very few sinuate based and if so, the depression is not abrupt. Disk ring almost always broad with indefinite demarcation on the border. Calyx usually well developed up to the smallest fruits: Long, narrow-lobed ones exist, short lobed members almost missing. Apex very slightly depressed, dots in many cases absent around the stylar point. Occasionally areolate. Navel mostly greatly developed, sometimes bursting at one side, being too wide open. Surface almost always smooth at the apex, but a certain number of fruits are more or less pitted at the base. Color mostly yellowish orange, but there are a few orange and deep orange grades. Green color still predominates in many fruits up to the highest grade. Conclusion before measurement: All typical to Wase under close observation, each lot looking quite similar. It is greatly different from the fruit examined at the same time, taken from a neighbouring tree of Owari (Lot No. 100.)

The measurements of these lots are given in Tables 95, 96, 97, 98, and 99.\*

In explanation of the photographs of the three largest fruits of each tree the following notes were taken:

Three largest fruits of No. 1 tree lot (Nos. 8470, 8471, and 8472) have thin rind, deep-colored surface with comparatively fine-grained pulp. Pith rather abundant, taste slightly acidulous, except the last. Segments irregular in the last number.

Three largest fruits of No. 2 tree lot (Nos. 8367, 8368, and 8369) have thin rind (last one slightly thicker). Pulp more or less deep-colored, finely grained, rather anastomose, medium in flavor. Segments rather irregular, wall more or less thick. Pith rather abundant. No. 8368 fruit contains 2 seeds.

Three largest fruits of normal Wase part of No. 3 tree lot (Nos. 8403, 8404, and 8405) have slightly smaller size than others. Segments more regular than in the preceding lot. Central column slightly smaller, wall equally more or less thick. Vesiculation similar to the above, both being anastomose, though not coarse. The first fruit is well colored in

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\* PL. XXI, Fig. 2—PL. XXII, Fig. 2.

TABLE 95.

MEASUREMENT OF FRUITS FROM THE ORIGINAL TREE NO. 1 OF THE KAWANO  
WASE AT AOE, ÔITA-KEN. LOT NO. 123 OF 1924. TOTAL NUMBER  
OF FRUITS, 60 (NOS. 8470-8529).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.50 cm.	4.13 cm.	1.34	73.02 gm.	10.00 mm.	11.15	1.67 mm.	10.47 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	60	—	—	—	—	—	45	75.00
Sinuate based fruits	60	—	—	—	—	—	5	8.33
Semi-sinuate based fruits	60	—	—	—	—	—	0	0
Areolated fruits	60	—	—	—	—	—	22	36.67
Frs. with undeveloped calyx lobes	59	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	59	—	—	—	—	—	6	10.17
Fruits containing seeds	60	—	—	—	—	—	2	3.33
Apical depression	60	0 0	2 3.33	57 95.00	1 1.67%	—	—	—
Apical dots	60	36 60.00	20 33.33	4 6.67%	—	—	—	—
Flatness of fruit	60	11 18.33	28 46.67	21 35.00	0 0	0 0%	—	—
Smoothness of fruit	60	36 60.00	24 40.00	0 0	0 0	0 0%	—	—
Thinness of rind	60	50 83.33	9 15.00	1 1.67	0 0	0 0%	—	—
Thinness of segment wall	60	48 80.00	12 20.00	0 0	0 0	0 0%	—	—
Color of pulp	60	21 35.00	18 30.00	9 15.00	8 13.33	4 6.67%	—	—
Size of central column	60	0 0	3 5.00	28 46.67	25 41.69	4 6.67%	—	—
Quantity of pith	60	2 3.33	19 31.67	38 63.33	1 1.67	0 0%	—	—
Quality of pulp	60	0 0	8 13.33	23 38.33	13 21.67	16 26.67%	—	—

**TABLE 96.**  
**MEASUREMENT OF FRUITS FROM THE ORIGINAL TREE NO. 2 OF THE KAWANO**  
**WASE AT AOE, ÔITA-KEN. LOT NO. 121 OF 1924. TOTAL NUMBER**  
**OF FRUITS, 36 (NOS. 8367-8402).**

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.50 cm.	4.30 cm.	1.37	86.50 gm.	10.34 mm.	11.33	1.74 mm.	10.85 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	36	—	—	—	—	—	29	80.56
Sinuate based fruits	36	—	—	—	—	—	8	22.22
Semi-sinuate based fruits	36	—	—	—	—	—	0	0
Areolated fruits	36	—	—	—	—	—	12	33.33
Frs. with undeveloped calyx lobes	35	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	35	—	—	—	—	—	4	11.11
Fruits containing seeds	36	—	—	—	—	—	5	13.89
Apical depression	36	0 0	3 8.33	33 91.67	0 0%	—	—	—
Apical dots	36	16 44.44	15 41.67	5 13.89%	—	—	—	—
Flatness of fruit	36	4 11.11	15 41.67	13 36.11	4 11.11	0 0%	—	—
Smoothness of fruit	36	9 25.00	26 72.22	1 2.78	0 0	0 0%	—	—
Thinness of rind	36	32 88.88	3 8.33	0 0	1 2.78	0 0%	—	—
Thinness of segment wall	36	16 44.44	18 50.00	2 5.56	0 0	0 0%	—	—
Color of pulp	36	10 27.78	17 47.22	5 13.89	2 5.56	2 5.56%	—	—
Size of central column	36	0 0	0 0	19 52.78	12 33.33	5 13.89%	—	—
Quantity of pith	36	5 13.89	15 41.67	14 38.89	2 5.56	0 0%	—	—
Quality of pulp	36	1 2.78	5 13.89	14 38.89	11 30.56	5 13.89%	—	—

TABLE 97.

MEASUREMENT OF FRUITS FROM NORMAL PART OF ORIGINAL KAWANO WASE  
 TREE NO. 3 AT AOE, ÔITA-KEN. LOT NO. 122 OF 1924. TOTAL  
 NUMBER OF FRUITS, 67 (NOS. 8403-8469).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.51 cm.	4.14 cm.	1.39	73.30 gm	10.31 mm.	11.09	1.82 mm.	9.94 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	67	—	—	—	—	40	59.70%
Sinuate based fruits	67	—	—	—	—	4	5.97
Semi-sinuate based fruits	67	—	—	—	—	0	0
Areolated fruits	67	—	—	—	—	30	44.78
Frs. with undeveloped calyx lobes	62	—	—	—	—	3	4.84
Frs. with long narrow calyx lobes	62	—	—	—	—	13	20.97
Fruits containing seeds	67	—	—	—	—	1	1.49
Apical depression	67	0 0	4 5.97	59 88.06	4 5.97%	—	—
Apical dots	67	34 50.75	29 43.28	4 5.97%	—	—	—
Flatness of fruit	67	8 11.94	19 28.36	34 50.75	6 8.96	0 0%	—
Smoothness of fruit	67	41 61.19	25 37.31	1 1.49	0 0	0 0%	—
Thinness of rind	67	59 88.06	3 4.48	3 4.48	1 1.49	1 1.49%	—
Thinness of segment wall	67	49 73.13	18 26.87	0 0	0 0	0 0%	—
Color of pulp	67	17 25.37	32 47.76	10 14.93	5 7.46	3 4.48%	—
Size of central column	67	0 0	3 4.48	19 28.36	29 43.28	16 23.88%	—
Quantity of pith	67	3 4.48	26 38.81	36 53.73	2 2.99	0 0%	—
Quality of pulp	67	1 1.49	5 7.46	20 29.85	20 29.85	21 31.34%	—

TABLE 98.

MEASUREMENT OF FRUITS FROM TOP-WORKED PART OF ORIGINAL KAWANO  
WASE TREE NO. 3 AT AOE, ÔITA-KEN. LOT NO. 124 OF 1924. TOTAL  
NUMBER OF FRUITS, 58 (NOS. 8530-8563, 8567-8590).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.50 cm.	4.19 cm.	1.33	76.73 gm.	10.44 mm.	10.94	1.78 mm.	9.31 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	58	—	—	—	—	—	29	50.00
Sinuate based fruits	58	—	—	—	—	—	7	12.07
Semi-sinuate based fruits	58	—	—	—	—	—	0	0
Areolated fruits	58	—	—	—	—	—	39	67.24
Frs. with undeveloped calyx lobes	54	—	—	—	—	—	2	3.70
Frs. with long narrow Calyx lobes	54	—	—	—	—	—	15	27.78
Fruits containing seeds	58	—	—	—	—	—	2	3.45
Apical depression	58	0 0	3 5.17	51 87.93	4 6.90	—	—	—
Apical dots	58	30 51.72	27 46.55	1 1.72%	—	—	—	—
Flatness of fruit	58	6 10.34	21 36.21	23 39.65	8 13.79	0 0%	—	—
Smoothness of fruit	58	37 63.79	19 32.76	2 3.45	0 0	0 0%	—	—
Thinness of rind	58	53 91.38	3 5.17	2 3.45	0 0	0 0%	—	—
Thinness of segment wall	58	42 72.41	15 25.86	1 1.72	0 0	0 0%	—	—
Color of pulp	58	8 13.79	31 53.45	17 29.31	1 1.72	1 1.72%	—	—
Size of central column	58	0 0	3 5.17	16 27.59	25 43.10	14 24.14%	—	—
Quantity of pith	58	2 3.45	24 41.38	24 41.38	7 12.07	1 1.72%	—	—
Quality of pulp	58	0 0	7 12.07	26 44.83	20 34.48	5 8.62%	—	—

TABLE 99.

MEASUREMENT OF FRUITS FROM THE ORIGINAL TREE OF THE KAWANO  
WASE NO. 4 AT AOE, ÔITA-KEN. LOT NO. 120 OF 1924. TOTAL  
NUMBER OF FRUITS, 63 (NOS. 8304-8366).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.50 cm.	4.29 cm.	1.37	84.68 gm.	10.63 mm.	10.97	1.96 mm.	10.56 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	63	—	—	—	—	—	42	% 66.67
Sinuate based fruits	63	—	—	—	—	—	9	14.29
Semi-sinuate based fruits	63	—	—	—	—	—	0	0
Areolated fruits	63	—	—	—	—	—	40	63.49
Frs. with undeveloped calyx lobes	60	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	60	—	—	—	—	—	7	11.67
Fruits containing seeds	63	—	—	—	—	—	0	0
Apical depression	63	0 0	8 12.70	53 84.13	2 3.17%	—	—	—
Apical dots	63	26 41.27	35 55.56	2 3.17%	—	—	—	—
Flatness of fruit	63	11 17.46	25 39.68	23 36.51	4 6.35	0 0%	—	—
Smoothness of fruit	63	31 49.21	31 49.21	1 1.59	0 0	0 0%	—	—
Thinness of rind	63	48 76.19	9 14.29	4 6.35	2 3.17	0 0%	—	—
Thinness of segment wall	63	38 60.32	23 36.51	2 3.17	0 0	0 0%	—	—
Color of pulp	63	9 14.29	23 36.51	24 38.10	5 7.93	2 3.17%	—	—
Size of central column	63	0 0	8 12.70	27 42.86	19 30.16	9 14.29%	—	—
Quantity of pith	63	3 4.76	30 47.62	25 39.68	5 7.93	0 0%	—	—
Quality of pulp	61	0 0	3 4.92	27 44.26	21 34.43	10 16.39%	—	—

cross-section (pulp). Its pulp tastes good ; others have medium flavor. No particular point in any respect.

Three largest fruits of top-worked part of No. 3 tree lot (Nos. 8530, 8531 and 8532) have thin rind, fine vesicles, small central column, and good-colored juicy pulp. Quality is apparently better than in others. Segment wall more or less thin, pith slightly less in quantity, vesicles anastomose but not whitened nor dried.

The plant received at first two different buds, one being the Wase and the other the ordinary kind. The latter has been cut back and top-worked with Wase bud, which developed into the present lot.

In the three largest fruits (Nos. 8305, 8306, and 8307) of the No. 4 tree lot, anastomose large distinct vesiculation of pulp is conspicuous. Rind thin, more or less thickened by scab infection. Pulp not deep-colored, wall rather thick. The last of the three has more or less finer vesiculation ; first two fruits have smaller central column. Taste about the same, medium in grade.

From the mass study of the cross-sections of the Kawano Wase fruits (5 lots), the following notes were taken.

No. 1 tree lot. Rind varying from very thin (less than 1 mm.) to medium-thick (3 mm.), none more than that. Segment usually thin ; only in larger fruits slightly thicker. Segments very irregular. Pulp vesicles generally fine. Color of pulp varying from deep to light, flavor ranging from medium-good to very acid. Central column small to medium-large. Pith medium-little to medium-much, usually medium-much. Quality not good, very fluctuating. (Nov. 3, 1924)

No. 2 tree lot. Rind usually thin or slightly medium-thin, an exceptional cull with medium-thick rind. Segment wall generally thin to medium-thin. Central column much smaller, quantity of pith varying as usual. Quality not good, averaging medium. Exceptionally thin rind one (No. 8399) has good quality. It is noticed that the color of fruit does not exactly correspond to the maturity of the pulp. (Nov. 5, 1924)

No. 3 tree lot. Rind thin, with very few exceptions. Segment wall thin to medium-thin, in no case thicker than that. Color of pulp

varying; there are deep-colored ones among the smaller members. Pith of the central column is more abundant than in the former, and quality of pulp is also inferior. Some deep-colored pulp tastes acid, generally too acid and none has good quality. (Nov. 6, 1924)

No. 3 tree lot (top-worked part). About similar to the above. Fruits had become somewhat dry at the time of investigation, and color of pulp seems to have advanced, only a few remaining medium, almost none remaining light-colored. Taste generally more improved than in the previous lot, but it is not certain whether this is due to storage, or to the better quality of the budded clone than the original. Perhaps both are combined. Repeated multiplication seems to give an effect of improving the quality of the crop through unintentional selection. (Nov. 12, 1924)

No. 4 tree lot. In comparison with the former, this lot has a taste slightly more acid in flavor. (Nov. 14, 1924)

#### *Conclusion from the statistical study*

The shape of the Kawano Wase fruit is tall depressed-globose, but it is flatter than it looks when the D/H index is taken. It ranges from 1.33 to 1.39, averaging 1.36. Size of the fruit is not normal, due to the unfavorable condition of the trees, yet the average figure is not very small. The computed average diameter of fruit of each lot is 5.54 cm., 5.88 cm., 5.57 cm., 5.57 cm. and 5.89 cm., respectively, the total average being 5.69 cm. Many fruits show distinct navel marks, and the area around the stylar point is naked, lacking oil glands. The presence of areola around the stylar point is not a feature in the Wase, but it runs up to 67% in a certain case. The nature of the areola is not a strongly pitted one, for it is only marked by a circle abruptly lacking oil cell dots. The clearness of the areola is perhaps due to the infection of sour scab and rust mite. The large size of the calyx can also be seen, not only in the figure but in the existence of elongated lobes, which run as high as almost 28 per cent. A remarkable number of smooth fruits is very characteristic, and the thinness of the rind is very pronounced,



The segment wall is not thin, according to the figures, 91 out of 284 fruits (32%) have a thicker wall than normal (thin). The condition of maturity is considerably retarded by the bad condition of the tree and the severe infection of sour scab, and both the color of the pulp and its flavor were altogether of a lower grade than normal, but characters of deterioration (often found in the crop of a dying plant) were entirely absent. The acidity of the fruit is also greater, due to malnutrition and the lack of care, although the large size of the pulp vesicles is scarcely affected by such conditions of the tree. Smallness of central column is also a remarkable character of Kawano Wase, none of the fruit having a large core, and only 18 fruits (6.3%) having a slightly larger core than normal (medium). Quantity of pith of the central column is unquestionably much more than in other varieties. Only 10 fruits (3.5%) contained seeds, probably due to the presence of a *Natsudaidai* plant (*Citrus natsudaidai* HAYATA) in the vicinity, which supplied the pollen. Although the material was not ideal in representing the variety, the characteristic points of the Wase Satsuma, now commercially known, are all well marked in the fruits of these original plants, from which nearly all bearing Wase plants now planted commercially were propagated.

### OWARI SATSUMA PLANTED NEAR THE ORIGINAL PLANTS OF KAWANO WASE

A tree of apparent Owari variety of Satsuma orange, existing on the northern side of the No. 2 tree of the original Kawano Wase Satsuma tree (PL. XLIX, Fig. 3) was studied for the purpose of comparison with the latter. The tree is at a distance of 1.74 m. from the No. 2 tree, and about 2.62 m. in spread. This tree looks as if it were propagated the same time the original KAWANO Wase plants were grafted, and the scion is possibly of similar origin, coming from the same place. At a glance, the tree shows fewer but larger-sized, deeper-colored leaves than the other. The trifoliate stock is shown above the ground, and the main trunks forked from the large foot trunk are very low spreading. The

number of branches is less than those of the above. The tree is cared for almost exactly like the other Wase trees nearby.

The fruit of this tree, studied in 1924, was picked at the same time the Wase fruits were harvested. The lot No. 119, Table 100\*, presents a remarkable difference from the other. The difference is briefly summarized as follows:

1. Size of fruit is decidedly smaller.
2. Shape of fruit is more uniform, flatter and less rectangular in outline.
3. Maturity of fruit is a great deal later, none of the fruit attaining a yellowish orange color, green part being predominate.
4. Fruit is more compact, not soft as in the Wase fruit.
5. Surface is more pitted.
6. The flatness of the apex is about similar, but the naked area around the styler point is not pronounced. Areola present in about the same degree.
7. Navel is less prominent.
8. Calyx is smaller and more uniform in shape and size. Lobe part is less developed, the body (tube part) being better developed.
9. Stem-end is more decidedly depressed; disk ring is never developed and the demarcation is always clear. Double ring around the calyx is often present.
10. Percentage of sour scab infection is probably less in extent, but infected ones are often more severe than those of the Wase. Tubercular protrusion is frequent.
11. Rust is not so serious as in the Wase fruit. No russet fruit. Certain percentage of the fruit is absolutely free from rust or scab.
12. Melanose infection is rarely seen. No other blemishes exist. The rind seems more firm than the Wase.

The measurements of the fruits of this lot are given in Table 100.

The section of the three largest fruits (Nos. 8151, 8152, and 8153) has rather thin rind, medium or small (No. 8152) central column, and

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\* PL. XXII, Fig. 3.

TABLE 100.

MEASUREMENT OF FRUITS OF OWARI PLANTED IN THE VICINITY OF ORIGINAL  
KAWANO WASE TREES AT AOE, ÔITA-KEN. LOT NO. 119 OF 1924. TOTAL  
NUMBER OF FRUITS, 153 (NOS. 8151-8303).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
15.51 cm.	3.67 cm.	1.38	51.04 gm.	9.43 mm.	10.97	1.92 mm.	7.47 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	153	—	—	—	—	—	42	27.45
Sinuate based fruits	153	—	—	—	—	—	84	54.90
Semi-sinuate based fruits	153	—	—	—	—	—	0	0
Areolated fruits	153	—	—	—	—	—	97	63.40
Frs. with undeveloped calyx lobes	152	—	—	—	—	—	4	2.63
Frs. with long narrow calyx lobes	152	—	—	—	—	—	1	0.66
Fruits containing seeds	141	—	—	—	—	—	24	17.02
Apical depression	153	0 0	4 3.61	121 79.08	28 18.30%	—	—	—
Apical dots	150	9 6.00	93 82.00	48 32.00%	—	—	—	—
Flatness of fruit	153	27 17.65	71 46.41	43 28.10	11 7.19	1 0.65%	—	—
Smoothness of fruit	153	10 6.54	100 65.36	39 25.49	4 2.61	0 0%	—	—
Thinness of rind	141	73 51.77	47 33.33	18 12.77	2 1.42	1 0.71%	—	—
Thinness of segment wall	141	64 45.39	68 48.23	9 6.38	0 0	0 0%	—	—
Color of pulp	141	5 3.55	17 12.06	44 31.21	32 22.70	43 30.50%	—	—
Size of central column	141	43 30.50	64 45.39	34 24.11	0 0	0 0%	—	—
Quantity of pith	141	74 52.48	58 41.31	8 5.67	1 0.71	0 0%	—	—
Quality of pulp	140	0 0	0 0	7 5.00	33 23.57	100 71.43%	—	—

thin segment wall. The wall of the segment is not thickened at the center of the fruit as in the Wase. Pulp is very finely grained and the vesiculation indistinct. Color of pulp is very light, the contrast with the Wase being very great, showing less advanced maturity. They taste acid.

The section of the whole lot shows fruit extremely immature and acid. The thinness of the rind is variable from thin to thick, but many are thin. Color of pulp is also extremely variable, some are very light, even greenish. Central column is usually small, meaning immature, still developing and therefore pith is abundant. Thickness of the segment wall is variable, but is not thin on an average. Strangely, a few fruits are much advanced in maturity, having a deeper colored pulp and a less acidic flavor. Such fruits have a thinner rind, almost as thin as those of the Wase.

In comparing the statistical figures with those of the Wase fruits, it is clearly seen that the Owari fruits have less navelled fruit and a larger percentage of sinuate based fruits. Number of areolated fruits is not greater, but there are many pitted areola, which are rather few in Wase, amounting to about 20 per cent. A very low percentage of calyces with well developed lobes are seen, and the percentage of fruits with a naked apex is also conspicuously low. In Wase, the fruit of the medium-flat grade seldom exceeds that of the medium grade in numbers, but here the former is almost double the latter in amount. This shows that more flat fruits are among the Owari, although these fruits were increasing in size when observed. It can be seen in the D/H index that the flatness is almost similar in degree, when the Owari fruit is in such an immature condition, and a still further increase in flatness is to be expected. Smoothness of the fruit is also very different. Rind is fairly thin but the number of medium-thin fruits is very much more than in Wase. Thinness of segment wall is also increased, but this may be partly due to the higher percentage of seed-bearing fruits. The reason for seediness is unknown, because if it is due to cross pollination, the Wase fruit should be equally affected. It may be due to the difference in the power of apogamic seed formation in these two varieties. All other immature

characters, such as a larger percentage of light-colored pulp, acid fruits, small central column, and so on, are also noticed. A smaller amount of pith is more pronounced than in the Wase fruit, even at this stage.

### FRUIT TESTING OF THE YAKUSHIJI WASE (1)

In 1919, it was requested that the crop of this tree be saved for study, but the owner did not fill the order, though he accepted it. Only 10 culls found on the tree after the pick were obtained, and the data is given in Table 101. The size of the fruits was considerably small, and the shape was tall, although they were typically polished and with flat ends and large calyces.

TABLE 101.

MEASUREMENT OF LATE PICK CULLS OF THE ORIGINAL TREE OF YAKUSHIJI WASE IN 1919. TOTAL NUMBER OF FRUITS, 10.

Av. Girth	Av. Diam.	Av. Height	D/H Index	No. Segm'ts.	Rind	Center	Seedy fruit
14.8 cm	4.71 cm.	3.93 cm.	1.20	10.1	2.10 mm.	7.55 mm.	1

In general, the thickness of rind of these fruits was medium and that of the segment wall was thin. Color of fruit was not very much advanced but the pulp was good-colored and juicy in all cases. The three largest fruits picked for photographing were beautifully colored, but all were subacid or acid in taste, possibly due to the infection of sour scab and melanose. These fruits were picked on Oct. 30, 1919, and were studied on the same and the next day. There was only one fruit which had a developed navel mark.

In 1920, a second request was made to leave the fruit on the tree until the writer should call and make a study himself. This request was accepted, but when the tree was visited on Oct. 19, no fruits were found remaining on it, because they had been picked and sold notwithstanding the promise. The owner, however, had saved a few fruits for home use, and they were turned over to the writer. These fruits were fully mature

and had an excellent flavor, though the color was not very bright and green patches were still present. All of the four fruits tested were smooth, medium in flatness, apex only slightly depressed, and none had a naked area around the stylar point. Every fruit had a flat base, two fruits showed a distinct double ring surrounding the calyx. Areola was present in three fruits, and all had well developed navel marks. Rind was thin in all of them, but the segment wall was medium-thin in three of them, one being thin. Color of pulp was all medium-deep, taste medium-good to nearly good. Central column was small to medium, and the amount of pith was medium. There was found a slight infection of sour scab. None of the fruits had a button, apparently being pulled down from the branch. One fruit contained 3 seeds. The average dimensions of the fruit are given in Table 102.

TABLE 102.

MEASUREMENT OF FRUITS FROM THE ORIGINAL TREE OF THE YAKUSHIJI WASE, AOE, ÔITA-KEN. LOT NO. 3 OF 1920. 4 FRUITS (NOS. 123-131).

Av. Girth	Av. Diam	Av. Height	D/H Index	Weight	Diam. of disk	No. Segm'ts.	Rind	Center	Seedy fruit
21.80 cm.	6.94 cm.	5.08 cm.	1.37	gm. 130.0	9.8 mm.	11.5	1.94 mm.	13.6 mm.	1

In 1924 it was still impossible to secure a faithful offering of fruit samples, notwithstanding the kind assistance of the village office. Only one advance pick of the fruit was studied, and the measurements of it are given in Table 103.

TABLE 103.

MEASUREMENT OF A FRUIT (NOS. 8141) OF YAKUSHIJI WASE IN 1924.

Girth	Diameter	Height	D/H Index	Weight	Calyx	No. Segm'ts.	Rind	Center	Seed
19.7 cm.	6.27 cm.	4.6 cm.	1.36	90.0 gm.	12.0 mm.	11.0	mm. 2-2.5	mm. 11×9	0

The color of the fruit was at the third grade, and green patches were present. It had a flat base with typical double ring, large navel mark, broadly shallow concave apex, medium-flat outline, smooth skin,

few dots around the stylar point, and an areola. Calyx lobes were long and narrow. Both rind and the segment wall were thin, and the central column was medium-small. Pith was medium in quantity and the pulp tasted subacid.

### FRUIT TESTING OF YAKUSHIJI WASE (2)

At a strong request of the writer, the village master persuaded the owner to supply experimental material for study, and 33 fruits were sent to Fukuoka, arriving on November 19th, 1926. These fruits were taken from a single branch best representing the crop of the year, as observed in advance during a thorough inspection of the writer. This year the tree was in an over-bearing condition, and the fruits were all small. The description of the material is given below :

Fruits ranging from medium to small in size, fairly uniform in shape, grading normally; appearance beautiful. Large ones medium in size, but the small ones are rather too small. Shape is generally medium, occasionally high, but never conspicuously so, especially in the large-sized ones. Flat ones are also not extremely flat. The shoulder part of both apex and base moderately rounded, not being thin nor conical (except No. 10655, which has a more or less pointed base.) Stem-end moderately pressed (must have been flat when young), never abruptly sinuous. Calyx rather large, some show conspicuously elongated lobes; disk medium-large, usually half concealed under the calyx, often much enlarged, extending broadly. The expansion of the disk seems not so large as in the Kawano Wase. The fine striation radiating from the calyx is becoming indistinct. Fruits apex rounded, stylar end only slightly concave, generally nearly flat. Naked area usually conspicuous, navel marking is not prominent, being sparingly present. Surface becoming slightly pitted from the fruit being kept too long on the tree, but still smooth or even, with prominent oil cell dots. All bright-colored, sparingly green-spotted. Some fruits rusty, but not to a great extent.

The Wase features are unquestionably clear in this lot, though the basal characters are becoming more or less indistinct, compared to the

time they were observed on the tree in early October. Smallness of the fruit was inevitable as the tree is getting old. Pitting of the surface is increasing since it was observed on the tree, and fruit No. 10655 is particularly pitted, probably being a late bloom fruit. The size of the calyx and the disk ring is not so large as was expected.

These points make this somewhat different from the Kawano Wase, but a close watch shows that no serious distinction exists between these two. Some fruit shows more or less distinct radial grooves from the stem-end. This is due to the over-mature condition of the fruit. (Remarks on Nov. 20, 1926.)

The color of the fruit is bright but is not intense as yet, green spots being rather too frequent. Russet fruits do not seem to lose the smooth appearance of their surface. Some fruit have very large oil cell dots, a typical Wase character without mistake. Average shape is more or less tall, due to the small size. (Remarks on Nov. 22, 1926.)

The section of fruits is beautiful, quite desirable and attractive looking. Rind uniformly thin, and the segment wall also equally thin. Central column moderately small, round, regular, and the pith comparatively small in amount. Pulp intensely colored, very transparent, no whitening which causes a coarse appearance. Pulp vesicles large, reticulate, never parallel, their wall extremely thin, containing abundant juice. The pulp shows a kind of play of color (due to reflection of light on the vesicle wall) and such pulp is always good in quality, being very juicy and extremely transparent. Flavor is sweet enough and exceedingly palatable, only rarely lacking intense sweetness, but never acidulous nor insipid: of markedly good quality. Only one green fruit (No. 10955) tastes acidulous. No. 10667 fruit has a large center and a more or less large quantity of pith, but the quality of the pulp is just as good. The difference in size of segments is not great, and the segments are rather many, ranging from 9 to 12. They are absolutely seedless. (Remarks on Nov. 22, 1926.)

The measurements of fruits are given in Table 104.\*

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\* PL. XXII, Fig. 4.



TABLE 104.

MEASUREMENT OF FRUITS FROM THE ORIGINAL TREE OF YAKUSHUJI WASE  
AT AOE, OITA-KEN. LOT NO. 181. OF 1916. TOTAL NUMBER OF  
FRUITS, 33 (NOS. 10641-10673).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.07 cm.	4.40 cm.	1.30	80.21 gm.	10.91 mm.	11.15	1.99 mm.	12.42 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	33	—	—	—	—	—	8	24.24%
Sinuate based fruits	33	—	—	—	—	—	1	3.03
Semi-sinuate base fruits	33	—	—	—	—	—	0	0
Areolated fruits	33	—	—	—	—	—	16	48.48
Frs. with undeveloped calyx lobes	33	—	—	—	—	—	4	12.12
Frs. with long narrow calyx lobes	33	—	—	—	—	—	1	3.03
Fruits containing seeds	33	—	—	—	—	—	0	0
Apical depression	33	0 0	0 0	29 87.88	4 12.12%	—	—	—
Apical dots	33	18 54.55	15 45.45	0 0%	—	—	—	—
Flatness of fruit	33	0 0	8 24.24	15 45.45	7 21.21	3 9.09%	—	—
Smoothness of fruit	33	16 48.48	17 51.52	0 0	0 0	0 0%	—	—
Thinness of rind	33	33 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	33	32 96.97	1 3.03	0 0	0 0	0 0%	—	—
Color of pulp	33	0 0	0 0	33 100.00	0 0	0 0%	—	—
Size of central column	33	0 0	1 3.03	20 60.61	11 33.33	1 3.03%	—	—
Quantity of pith	33	0 0	1 3.03	20 60.61	12 36.36	0 0%	—	—
Quality of pulp	33	30 90.91	1 3.03	2 6.06	0 0	0 0%	—	—

In examining the statistical data, it is seen that the percentage of navel-ed fruit is considerably small in this lot. The development of the navel is, however, a great deal dependent on the size of the fruit, as seen in the results of the preceding years. The small number of sinuated based fruit, in comparison with the Kawano Wase, is possibly due to the full maturity of the samples. All other points are self evident and need no comment.

From this investigation, it was concluded that the identity of the the Kawano Wase with this tree could not be reached unless more material and evidence were at hand. Consequently this lot is provisionally named "Yakushiji Wase", and was described by the writer in 1927<sup>(173)</sup> as a strain of the Wase variety of the Satsuma orange.

### FRUITS OF KAWANO WASE IN COMMERCIAL PLANTING (1)

In 1919, many commercial plantings of the Wase Satsuma were visited, and preliminary studies were made on the quality of the fruit from a commercial standpoint. After handling the Wase fruits more than twenty years, Mr. Gosaku SUEOKA of Ôchô, Hiroshima-ken, expressed his opinion that typical samples of Wase fruits have the most desirable shape and size as merchandise. According to his suggestion, three typical fruit samples were picked from a tree in his orchard on Oct. 24, 1919, just one month after the first commercial pick was made. These fruits were studied on Oct. 29, and they were all beautifully colored and smooth. The character of dots forming fine streaks at the calyx-end and being absent around the styler point, was noticed. In halving the fruit, thin rind, small central column, and beautifully colored pulp of excellent flavor were observed. Pith in the center was more or less solid. Average size of the fruit is given in Table 105.

TABLE 105.

MEASUREMENT OF 3 FRUITS OF COMMERCIAL KAWANO WASE FROM SUEOKA'S ORCHARD AT ÔCHÔ, HIROSHIMA-KEN, IN 1919.

Av. Girth	Av. Diam.	Av. Height	D/H Index	No. Segm'ts.	Av. Rind	Av. Center	Seeds *
22.2 cm.	7.08 cm.	5.23 cm.	1.33	11-12	2.5-3 mm.	12-15 mm.	0

Similar looking fruits (8 in all) of the Kawano Wase, which had been shipped from Ôchô, were purchased at the Kobe market on Nov. 3, 1919. Seven fruits were sent to Washington, carefully packed in a strong wooden box filled with moist sawdust. They arrived at their destination on Dec. 5,\* in good condition, and two of them were photographed and published later in the Journal of Heredity, Vol. XIII, no. 6, p. 244 (1922). The measurements of these eight fruits are given in Table 106.

TABLE 106.

MEASUREMENT OF 8 KAWANO WASE FRUITS PURCHASED IN KOBE IN 1919.

Av. Girth	Av. Diam.	Av. Height	D/H Index	No. Segm'ts.*	Rind*	Center*	Seeds*
22.7 cm.	7.28 cm.	5.40 cm.	1.35	11	2-3.5 mm.	15 mm.	0

\* Only one fruit was halved

Three fruits of the Kawano Wase were obtained on Oct. 25, 1919 from Fukumatsu MYÔKEN, a local packer of Ôchô village. They were also similar looking, and a trial was made in storing them. One fruit tested on Nov. 13 was excellent in flavor, although the skin was a little dried. The other studied on Nov. 19 was also slightly dried, but was still very juicy and delicious, being sufficiently sweet. The last, kept until Dec. 8, also remained in excellent condition and was very good tasting. The measurements of these fruits are given in Table 107.

TABLE 107.

MEASUREMENT OF 3 FRUITS OF THE KAWANO WASE OBTAINED FROM MYÔKEN AT ÔCHÔ, IN 1919.

Av. Girth	Av. Diam.	Av. Height	D/H Index	No. Segm'ts.	Rind	Center	Seeds
20.4 cm.	6.45 cm.	4.68 cm.	1.37	10.0	2.5 mm.	11.5 mm.	0

From Tsukumi, another big Wase growing section, several samples of commercial Kawano Wase fruits were obtained. They were not so attractive as the Ôchô fruits, due to the lack of sufficient fertilizing and

spraying. The first lot, from MURAKAMI's orchard, were much smaller in size and tasted still subacid on Nov. 14, 1919. The second lot, from a bin of YAMAROKU's, a local packer, were better in color and taste, although melanose infection was somewhat conspicuous. The measurements of 7 fruits from the first lot and two fruits from the second lot, are given in Table 108.

TABLE 108.

MEASUREMENT OF FRUITS OF THE KAWANO WASE FROM TSUKUMI IN 1919.

Lot	Av. Girth	Av. Diam	Av. Height	D/H Index	Segm'ts.	Rind	Center	Seeds
1	19.0 cm.	5.94 cm.	4.66 cm.	1.28	10.7	2.43 mm.	mm. 9.43	0
2	20.2	6.48	4.77	1.36	11.0	2.12	11.25	0

Except in these two places, Ôchô and Tsukumi, there was no economic cultivation of the Wase Satsuma at that time. Only a few growers planted Wase for trial, but no large plantation was seen even in Wakayama, the biggest growing section of the Satsuma orange. One fruit taken from a top-worked tree in the orchard of Risôda IKOMA, at Itogamura, Arita-gun, Wakayama-ken, was just as good as the fruits from Ôchô, but the grafted trees raised from the nursery bore fruits much smaller in size, due to over-bearing and to the lack of experience in bringing up the plants. Two representative fruits of the latter showed a remarkable quality of pulp. The measurements of these fruits are given in Table 109. These Wase trees were considerably smaller in size than the Owari trees planted in the same year and received equal treatment. They had typical short, broad, light-colored leaves.

TABLE 109.

MEASUREMENT OF WASE SATSUMA FRUITS OBTAINED AT IKOMA'S ORCHARD AT ITOGA-MURA, WAKAYAMA-KEN, IN 1919.

	Av. Girth	Av. Diam.	Av. Height	D/H Index	No. Segm'ts.	Rind	Center	Seeds
Top-worked tree	22.5 cm.	7.0 cm.	5.4 cm.	1.30	10	3.0 mm.	13.5 mm.	0
Grafted tree	18.55	5.85	4.55	1.29	9.5	1.87	8.75	0

**FRUITS OF KAWANO WASE IN COMMERCIAL PLANTING (2)**

In 1920, two plants of the Kawano Wase from a commercial planting were studied by the statistical method at Ôchô. This study was conducted in connection with the problem of variability of the Wase Satsuma, but the data about Wase fruits only is given here to show the general character of the variety. Brief descriptions of these plants are given below:

(1) A 15 year old tree belonging to Tôshirô HATSUMOTO, at Midzunashi, Ôchô-mura, Toyoda-gûn, Hiroshima-ken (PL. XLIX, Fig. 6.) The orchard is located on a new banking of the sea-shore about 3.5 m. above the sea level, being a flat land open to the east, and well drained. Subsoil, transported from a hill side, is rich in nutrient contents. Surface soil is pure beach sand, about 30 cm. deep. The sample tree is located on the fifth row from the water, and is the 5th tree from the south. Planting distance is about 3.46 m., the spread of the tree is E-W, 2.88 m., and N-S, 2.88 m., the height being 20.3 cm. It is a rather spreading tree. Originally two buds were inserted on a single root stock, the northern being Wase, and southern the ordinary Satsuma. The Wase trunk runs horizontally for a short distance\*, and then becomes upright. One thick branch of Wase comes out at the place where the trunk goes up, and bears typical Wase fruit even at the base. The erect trunk has many smaller adventitious shoots, heavily loaded with Wase fruits. Suddenly this trunk forks into large limbs, one bearing typical Wase fruits, the other bearing all Owari fruits\*\*. These fruits borne on adventitious sprouts from the trunk (Nos. 1-13) were studied in advance (Lot No. 1, Table 110\*\*\*) and the complete crop of the upper main branch (Nos. 135-331) was studied later (Lot No. 1, Table 111\*\*\*\*). The fertilization of the tree is not very heavy, consisting of a mixture of chicken-yard mud, bone dust, and silk worm pupa (or cotton seed cake). The tree is one of the second generation planted from the tree whose bud

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\* One adventitious shoot arising at the very bottom of this trunk bears typical Wase fruits, so that this trunk unquestionably started as the Wase.

\*\* This is a remarkable case of vegetative reversion, and will be discussed later.

\*\*\* PL. XXIII, Fig. 1.

\*\*\*\* PL. XXIII, Fig. 2.

TABLE 110.

MEASUREMENT OF 13 FRUITS OF THE KAWANO WASE FROM HATSUMOTO'S  
ORCHARD AT ÔCHÔ, HIROSHIMA PREFECTURE. LOT NO. 1  
OF 1920. FIRST PICK. (NOS. 1-13)

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.62 cm.	4.50 cm.	1.38	93.00 gm.	13.08 mm.	10.69	1.96 mm.	12.77 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	13	—	—	—	—	—	3	% 23.08
Sinuate based fruits	13	—	—	—	—	—	0	0
Semi-sinuate based fruits	13	—	—	—	—	—	0	0
Areolated fruits	13	—	—	—	—	—	10	76.92
Frs. with undeveloped calyx lobes	13	—	—	—	—	—	1	7.69
Frs. with long narrow calyx lobes	13	—	—	—	—	—	0	0
Fruits containing seeds	13	—	—	—	—	—	0	0
Apical depression	13	0 0	13 100.00	0 0	0 0%	—	—	—
Apical dots	13	11 84.61	2 15.38	0 0%	—	—	—	—
Flatness of fruit	13	3 23.08	9 69.23	1 7.69	0 0	0 0%	—	—
Smoothness of fruit	13	13 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of rind	13	13 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	13	9 69.23	3 23.08	1 7.69	0 0	0 0%	—	—
Color of pulp	13	0 0	2 15.38	10 76.92	1 7.69	0 0%	—	—
Size of central column	13	0 0	0 0	12 92.31	1 7.69	1 7.69%	—	—
Quantity of pith	13	3 23.08	1 7.69	7 53.85	1 7.69	1 7.69%	—	—
Quality of pulp	13	0 0	0 0	0 0	0 0	13 100.00%	—	—

TABLE 111.

MEASUREMENT OF 197 FRUITS OF THE KAWANO WASE FROM HATSUMOTO'S ORCHARD AT ÔCHÔ, HIROSHIMA PREFECTURE. LOT NO. 1 OF 1920.  
SECOND PICK (NOS. 135-331).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.68 cm.	4.64 cm.	1.41	108.58gm.	11.44 mm.	10.90	1.94 mm.	13.83 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	197	—	—	—	—	—	120	% 60.91
Sinuate based fruits	197	—	—	—	—	—	2	1.02
Semi-sinuate based fruits	197	—	—	—	—	—	1	0.51
Areolated fruits	197	—	—	—	—	—	118	59.90
Frs. with undeveloped calyx lobes	179	—	—	—	—	—	110	61.45
Frs. with long narrow calyx lobes	179	—	—	—	—	—	2	1.12
Fruits containing seeds	197	—	—	—	—	—	2	1.02
Apical depression	197	14 7.11	116 58.83	65 32.99	2 1.02%	—	—	—
Apical dots	197	100 50.76	89 45.18	8 4.06%	—	—	—	—
Flatness of fruit	197	74 37.56	86 43.65	35 17.77	2 1.02	0 0%	—	—
Smoothness of fruit	197	78 39.59	117 59.39	2 1.02	0 0	0 0%	—	—
Thinness of rind	197	194 98.48	2 1.02	1 0.51	0 0	0 0%	—	—
Thinness of segment wall	197	156 79.19	34 17.26	7 3.55	0 0	0 0%	—	—
Color of pulp	197	38 19.29	150 76.14	9 4.57	0 0	0 0%	—	—
Size of central column	197	2 1.02	21 10.66	123 62.44	40 20.30	11 5.58%	—	—
Quantity of pith	197	0 0	8 4.06	143 72.59	38 19.29	8 4.06%	—	—
Quality of pulp	196	25 12.76	91 46.43	71 36.33	9 4.59	0 0%	—	—

originally came from Ôita Prefecture. It was propagated by Mr. HATSU-MOTO, with a large trifoliate plant for the root stock.

210 fruits (Nos. 1-13, 135-331) were studied statistically. The first lot was picked and studied on Oct. 9, 1920, and the second was picked on Oct. 26 and studied on Oct. 30. Average size of fruit of this lot (Lot No. 1 of 1920) is large, small grade fruits (culls) are lacking. Average shape is depressed globose, surface very much polished, oil cells convex. Stem-end is flattened, only shallowly pressed in. Calyx is large-sized, disk ring large and often surpasses the lobe of the calyx. Navel mark rather prominent, areola semi-distinct, tightness of the skin is conspicuous, rarely splitting by its own expansion. Maturity of the last lot is almost complete, but with  $\frac{1}{5}$  of the area greenish. Blemishes very few. 13 fruits were found split during transit. (Fruits were sent to Tachima, Ôita-ken, where the measurements were taken on Oct. 30, 1930.)

The measurements of fruits are given in Tables 110 and 111.

The statistical figure shows that the fruits were fairly well matured when tested on Oct. 30th. This is shown not only by the comparative large amount of better tasting fruits but also by the small number of sinuate based fruits, the increased size of the central column, small amount of pith, and an increased development of oil cell dots which causes a slight increase in the roughness of the surface. The fruit of this lot should have essentially the same shape as that of the original trees of KAWANO (Tables 94-99), but the flatness of the fruit is a little increased, which is possibly due to the increased size of the fruit. Fruit No. 181 has an open center, and a more or less broadly depressed base. This fruit is suspected to be a reverted (Owari) fruit, as is discussed later.

Another lot of the Wase fruit from the orchard of Hisakichi MAMYÔ at Ôchô, Hiroshima-ken, gives an almost similar result in the individuality statistics. The data is given in a later chapter.



### VARIATION PROBLEM IN THE WASE SATSUMA (1)

It is a remarkable fact that there exists no Wase plantation in any part of Japan without a mix-planting of ordinary Satsuma individuals in the same orchard row. This fact is known to the grower as due to the variability of Wase buds, but it has never been called to the attention of the official horticulturist, and nothing is seen about it in the literature. In order to prove that there is such a mixed condition in Wase orchards, the writer examined the plants in the model orchard of the Prefectural Entomological Station at Tsukumi, Ôita Prefecture, where, in the neighbourhood, the oldest Wase plantations can be seen.

In this experimental station, 15 sample trees from a reliable source are planted to represent the Wase variety, and the same number of trees of Owari are also planted nearby. These trees, supposed to be all Wase, are planted in three rows, each row having five plants regularly planted at a distance of 4.33 m. apart. In the early fall of 1919 the plantation was examined carefully by the writer and each tree was numbered. Field observation brought the following result :

(1) No. 1 tree (First tree of the eastern row from the road, i. e., S-E corner of the plantation). Fruit is mature ; Wase characters are unquestionably present.

(2) No. 2 tree (Southernmost tree of the second row). Fruit is mature : Unquestionable Wase.

(3) No. 3 tree (Southernmost tree of the third row). Fruit is smaller, unripe, pitted. Undoubtedly Owari.

(4) No. 4 tree (Second tree from south on the first row). Few fruits on tree, same as above. Not Wase.

(5) No. 5 tree (Second tree of the middle row). Fruit is ripe : Wase characters clear.

(6) No. 6 tree (Second tree of the third row). Tree considerably upright, bearing quite unripe, late maturing fruits much smaller in size than Wase. Owari.

(7) No. 7 tree (Third tree of the first row). Fruit is well mature ; correctly Wase.

(8) No. 8 tree (Third tree of the middle row). Fruit is medium ripe, but the Wase characters are unquestionable.

(9) No. 9 tree (Third tree of the third row). Fruit large, medium ripe, but its Wase character is certain.

(10) No. 10 tree (Fourth tree of the first row). Not bearing. Discarded from the study.

(11) No. 11 tree (Fourth tree of the middle row.) Fruit is large-sized, medium ripe. Undoubtedly Wase.

(12) No. 12 tree (Fourth tree of the third row). Fruit slightly late maturing, but its Wase character is almost certain.

(13) No. 23 tree (Fifth tree of the first row). Fruit is smaller, semi-mature, but is Wase in every respect.

(14) No. 14 tree (Fifth tree of the middle row). Fruit is semi-mature. Wase.

(15) No. 15 tree (First tree of the third row, i. e., N-W corner). Fruit is medium ripe. Wase.

Among the 14 trees examined, three plants (21.4%) were not Wase. In order to verify the field observation, the entire crop of 1919 was investigated, through the courtesy of the prefectural station. A total of 463 fruits, picked from each tree separately, was received at Suma, Kobe, on Nov. 14, 1919. The study commenced on Nov. 16 and lasted until Dec. 10. The statistical figures are given in Table 112.

In the interpretation of the statistical figures, it is most clearly seen that the fruit of Owari is considerably smaller than the Wase fruits. Owing to the small size of the tree and its being under age, the crop is rather irregular, and the shape of the fruit is not uniform. At this stage of the development of the fruit, the flatness indicated by the D/H index of Wase and Owari is almost similar. While the Wase makes very little further development, the Owari will later increase more in diameter than in height, and will become flatter than it is this time. The Owari fruits have a smaller central column, and this is also due to the fact that the fruits are quite immature, and show little outward expansion. The thickness of the rind in the Owari fruit even at this stage, is well shown in the figure and the Owari will later also develop more in this respect. The basal character of the fruit is almost decisive, but it is not shown in the table. The Wase fruits have a large disk ring and fine radial striations from it, while the Owari fruit lacks this structure. All other minor points in relation to the characters of the fruit are omitted here.

From the result of the study given here, it can be clearly seen that even in the most reliable planting of the Wase variety, still a certain percentage of Owari Satsuma plants are mixed, even when they are all propagated from supposedly reliable Wase plants. It is unthinkable that

TABLE 112.

COMPARISON OF AVERAGE CHARACTERS OF FRUITS TAKEN FROM 15 TREES  
OF SATSUMA ORANGE, PLANTED IN WASE PLOT OF PREFECTURAL  
EXPERIMENTAL ORCHARD AT TSUKUMI, OITA-KEN.

Tree No.	No. fruits studied	Girth	Diam.	Height	D/H Index	Weight	No. Segm'ts.	Rind	Center	Seedy fruits
		cm.	cm.	cm.		gm.		mm.	mm.	
1	14	17.69	5.52	4.50	1.23	76.64	10.6	2.02	10.29	0
2	48	19.28	6.00	4.77	1.26	93.80	10.9	2.34	11.61	3
3*	40	16.59	5.14	3.96	1.30	56.84	11.2	2.62	10.49	2
4*	8	16.17	5.16	4.01	1.26	56.25	11.0	2.38	9.88	0
5	45	17.81	5.70	4.43	1.28	76.47	10.4	2.23	10.52	2
6*	32	16.30	5.09	3.96	1.28	56.44	10.6	2.88	9.84	2
7	60	16.95	5.31	4.06	1.30	63.61	10.3	2.11	10.84	2
8	35	18.60	5.92	4.54	1.30	85.85	10.2	2.11	11.24	1
9	85	18.87	5.68	4.47	1.29	81.05	10.3	2.30	11.22	0
11	17	20.53	6.40	5.14	1.25	109.53	10.1	2.91	11.32	0
12	15	19.03	5.95	4.13	1.44	91.80	11.3	2.72	11.50	1
13	6	19.15	6.13	4.82	1.29	95.50	10.2	2.25	10.25	0
14	17	16.57	5.22	4.23	1.23	65.18	10.4	1.88	8.68	0
15	19	18.79	5.86	4.61	1.27	89.84	10.1	2.22	10.61	1
Average		18.02	5.65	4.40	1.28	78.48	10.50	2.35	10.59	—
Average WASE		18.48	5.79	4.52	1.28	84.48	10.44	2.28	10.73	—
Average OWARI		16.25	5.13	3.98	1.28	56.51	10.93	2.63	10.07	—

\* The Owari trees are designated by asteristics

the irresponsibility of the nurseryman who supplied these plants resulted in this mixture, because the officer who set out this orchard plot is a horticulturist of high standing, and such would have occurred. It is quite clear that the mixture happened unexpectedly, and possibly resulted through an unintentional propagation of Owari buds. Mr. Hiromu GOTÔ, who was the first director of the station, told the writer that he had taken special precaution in the choice of the plants he set out there, and that, within his knowledge, race mixture was impossible. The existence of a similar condition in Wase planting was met with repeatedly in later observations, and not a single Wase orchard was encountered without a mixture of Owari plants. Such a situation requires a satisfactory explanation, because it is a serious matter if Wase plantings always suffer from an unconscious mixture of Owari plants.

Up to this time this problem never seriously caught the attention of scientists, while growers often claimed that the freak nature of Wase plant causes this trouble by yielding two kinds of buds.

In the early period of Wase planting at Ôchô, growers suffered a great deal from this trouble, in finding a certain percent of Owari trees from the buds they trusted surely to be Wase. They first attributed this fact to the mixture of the original budwoods brought from Ôita Prefecture. ISHIDA, who took back the Wase buds from Ôita, suspected the material which was given by MIYAZAKI at Tsukumi, because he did not collect the budwood himself, and never saw the trees that yielded these buds. He trusted KAWANO's buds because he was confident that he collected the right buds himself from the trees indicated by the owner to be Wase.\*

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\* Here is an unhappy episode which split the feeling of growers of Ôchô and Ôita. KAWANO claims that he offered the two upper trees (Trees No. 1 and 2 mentioned before), for budwoods, but on finding ISHIDA's umbrella in his orchard the next morning, he suspected that ISHIDA came early in the morning and stole more buds. ISHIDA claims that he took all available buds the first day and that no more buds were left on the trees, so that is why he asked for additional buds from other person. He also claims that he lost his umbrella somewhere, but he could not recollect where he had left it. He told the writer that he was permitted to cut budwoods from three plants (Tree No. 1, 2, and 3 mentioned before). If this is correct, the mixture of buds really has its origin in Tree No. 3, which has both Wase and Owari trunk, as stated before. It is the writer's opinion, that ISHIDA never stole the buds, because he highly appreciated KAWANO's generous offer, and he would never venture from safety to take buds from trees not indicated by the owner. MIYAZAKI is also a respectable person, and he clearly said that he took the budwoods himself, not wanting to bother his guest to climb the steep hill for only a few buds.

Among farmers who found the freak nature of the Wase plant, the name Ejûrô SHIMOMURA must be mentioned, because he was always enthusiastic to convince his fellow growers about the fact that Wase plants send out two kinds of branches and the propagator must be very cautious to prevent the mixture of buds. Ôchô growers soon learned the same fact, and they began to speak of this in a new term "manaru", meaning that the plant is mistaken in bearing a wrong branch. SHIMOMURA and other Ôita growers call this also by a similar term "machigau", or the mistake of the branch. The writer was told that both Prof. ONDA and Dr. KUMAGAI, members of the staff of the Imperial Horticultural Station, were informed by the Ôita growers about this branch behavior, but they were not convinced, having no chance for a critical examination. The author was first offered ideal material for investigation from the orchard of Mr. Gosaku SUEOKA of Ôchô in 1919, and was thoroughly convinced that this is a case of so-called "vegetative reversion" frequently found in plants, originated by either somatic or sexual mutation. At the same time the writer discovered that the Wase characters of the Satsuma orange can be created independently through the so-called "bud variation", "limb variation", or "bud mutation", and these two associated facts brought him to the conclusion that the commercial Kawano Wase must have been created by such a mutation<sup>(167)(168)(169)(170)(171)</sup>.

The next chapter will present cases of vegetative reversion of the Wase Satsuma.

## VARIATION PROBLEM IN THE WASE SATSUMA (2)

A few Wase plants at Ôchô, propagated by Tadaichi ISHIDA and now belonging to Hisakichi MAMÛ, were taken for investigation. There are about 70 plants set out very closely on a steep slope of an area of 8 acres, which includes 14 original plants, the buds of which were introduced from Ôita by ISHIDA himself. Among these 14 plants, 12 plants were Wase and 2 were Owari. One of the Wase trees, examined on Oct. 4, 1920, clearly shows its freak nature, one branch on the upright main trunk bearing Owari fruits, while 8 other limbs are all Wase. Two

smaller plants of MAMYÔ's orchard were chosen for a critical investigation, and a description of them is given below :

(1) The first tree (PL. XLIX, Fig. 7, 8, and 8<sup>a</sup>): Location ; Nishiminami orchard, on a moderately inclined terrace, third row from the bottom, first tree on the right hand side of the path. Distance to other trees on the same row of the terrace 3.46 m., and the distance to the upper tree on the next terrace 2.33 m. There are 1.2 m. to the path, 72 cm. to the edge of the terrace, and 1.2 m. to the bottom of the terrace, the height of the terrace being 58 cm. Tree was grafted in 1905, 2 years after the original trees were propagated from the buds introduced from Ôita. The E-W spread of the tree, 3.17 m., that of N-S, 2.9 m. This is a moderately expanding tree about 1.8 m. high with an open center, having a short trunk of 35 cm. in girth, immediately forking into two major trunks about 1.5 m. in girth at the bottom. The northern trunk bears typical Wase fruits only. The southern trunk runs for 12 cm., and divides into two closely-set thick branches. The western branch is Wase: the eastern branch runs straight for 30 cm., and then spreads horizontally for 1.74 m. parallel to the terrace, bearing entirely Owari fruits. It is impossible to imagine that two different buds were inserted at such a height and distance from the root. The tree is rather weak and old-looking, with many branches hanging. The leaves are rather loose, large-sized, undulate and mostly hanging: characters of the node are typical of Wase, except in the Owari part. Crop not large; typical for each type. Infection of black rot (caused by *Gloeosporium foliicolum* NISHIDA) prevails on the Wase fruits, causing the early drop of infected ones. The soil is rich archæan gravel loam, containing a quantity of angular gravel. The tree is well fed, but unpruned. The orchard is mulched with straw. (Remarks on Oct. 4, 1920)

(2) The second tree (PL. XLIX, Fig. 9, 10, and 10<sup>a</sup>). Same orchard; one tree below, i. e., on the second terrace row from the bottom, the first tree right of the path. Distances; 3.17 m. to the next tree of the same row, 2.33 m. to the tree above, 1.6 m. to the path, and 1.2 m. to the edge of the terrace. The E-W spread of the tree, 2.47 m., N-S spread, 2.88 m., and height 2.5 m. It is a rather tall tree, somewhat

weak-looking, with leaves similar to those on No. 1 tree. Girth of the swollen union near the ground, 33.1 cm.; main trunk runs upright for 14.5 cm. and then divides into two upright branch trunks, the eastern having a girth of 15.9 cm. at the bottom, the western 20 cm. at the same height. The eastern trunk bears rather low branches characteristic of the Wase with typical fruits. The western trunk runs upright for 34.5 cm., sends out one Wase branch and then runs upright inclining slightly southward. This straight upright branch runs for 43 cm. without any forking, having a girth of 13.6 cm. at the base, and bears green, compact fruits of decidedly Owari character on the terminal limb. The nature of this branch suggests that this was a very vigorous summer shoot from the beginning. The bottom of this strong Owari branch is characterized by somewhat irregular streaks running up and down, which give the impression that some disturbance took place during the first period of its growth. This is, however, not a sign of top-working or anything of the same nature. The tree bears a rather small crop but the fruits are larger than those of the first tree. This tree is not mulched, but is receiving the same treatment as the other.

*Studies of the crop of these two trees*

Unfortunately the crops of both trees were mixed up when they were picked but the Owari fruits were very easily segregated from the rest after the entire crop of 1920 was received. 107 fruits were sent, 10 of which were Owari. The crop was rather abnormal and the fruits were small, conical shaped ones were many. The Wase fruits are all well polished, fully expanded, tumid, and regular in outline. The stem-ends of these fruits are mostly crater-like but lack grooves. Calyx large-sized, but many with undeveloped lobes, and the disk is not prominent (especially so on No. 1 tree, when observed in the field). The majority of fruits have closed navels and negative areolas and the naked area around the styler point is pronounced. Every fruit is tight, but some are soft; all are fully mature in appearance. No blemishes, except a few with russet surface. (Remarks on Nov. 22, 1920.)

The measurements of both Wase and Owari fruits from both kinds of branches are given in Tables 113\* and 144.\*\*

The Owari fruits are smaller and flatter than the Wase fruits. The former have a smaller disk ring, thicker rind, more open central columns, lighter colored pulp, and more acidulous flavor. The smoothness of the Owari fruits is well marked, since they were grown under a shady condition in the crowded orchard.

### VARIATION PROBLEM IN THE WASE SATSUMA (3)

Since it became clear to the writer that some Wase trees, like MAMYÔ's two plants studied before, bear two kinds of branches on each tree, he conducted an investigation covering a broader field. On closer study both KAWANO's and YAKUSHIJÎ's original plants showed no such variation. Nevertheless, the oldest second generation trees of Kawano Wase clearly showed this phenomenon. The description of these trees studied is given below :

(1) Ten second generation trees propagated from the original trees of the Kawano Wase are planted at the Nidenoki plot at Aoe village by the same owners, (Nakaji KAWANO and his son, Tomitarô KAWANO). These plants were examined by the writer on Oct. 14, 1920. They were propagated in 1895 and 1896, the scions being top-worked upon already grown-up trifoliate stocks previously set out. The first four trees of the orchard row are straight Wase (No. 2 tree had died, and was later supplanted by a younger Wase tree). The fifth tree is partially Wase and partially Owari, two kinds of buds having originally been inserted on the same stock. The Owari bud came perhaps from the No. 3 tree of the original plot, which had both Owari and Wase branches until about 1900, as stated before. The sixth and seventh trees are Wase and the eighth tree took two kinds of buds from the start, as is the case of the fifth tree. One branch of the Wase part of this tree was found distinctly

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\* PL. XXIII, Fig. 4.

\*\* PL. XXIII, Fig. 5.



TABLE 113.

MEASUREMENT OF 97 FRUITS OF KAWANO WASE FROM WASE BRANCHES OF  
MAMYÔ'S PLANT AT ÔCHÔ, IN 1920. LOT NO. 4 OF 1920. (NOS. 1030-1178,  
1338-1354, 10 FRUITS LESS.)

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.55 cm.	4.86 cm.	1.28	96.45 gm.	10.29 mm.	10.92	2.05 mm.	11.73 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	97	—	—	—	—	—	18	18.56
Sinuate based fruits	97	—	—	—	—	—	16	16.60
Semi-sinuate based fruits	97	—	—	—	—	—	19	19.59
Areolated fruits	90	—	—	—	—	—	50	55.56
Frs. with undeveloped calyx lobes	94	—	—	—	—	—	99	70.21
Frs. with long narrow calyx lobes	94	—	—	—	—	—	0	0
Fruits containing seeds	97	—	—	—	—	—	0	0
Apical depression	96	<sup>4</sup> 4.17	<sup>28</sup> 29.17	<sup>51</sup> 53.13	<sup>13</sup> 13.54%	—	—	—
Apical dots	96	<sup>21</sup> 21.87	<sup>53</sup> 55.21	<sup>22</sup> 22.92%	—	—	—	—
Flatness of fruit	97	<sup>3</sup> 3.09	<sup>19</sup> 19.59	<sup>45</sup> 46.39	<sup>29</sup> 29.90	<sup>0</sup> 0%	—	—
Smoothness of fruit	97	<sup>51</sup> 52.58	<sup>41</sup> 42.27	<sup>5</sup> 5.15	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Thinness of rind	97	<sup>93</sup> 95.88	<sup>3</sup> 3.09	<sup>1</sup> 1.03	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Thinness of segment wall	97	<sup>74</sup> 76.29	<sup>19</sup> 19.59	<sup>4</sup> 4.12	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Color of pulp	97	<sup>54</sup> 55.67	<sup>34</sup> 35.05	<sup>9</sup> 9.28	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Size of central column	97	<sup>0</sup> 0	<sup>3</sup> 3.09	<sup>30</sup> 30.93	<sup>33</sup> 34.02	<sup>31</sup> 31.96%	—	—
Quantity of pith	97	<sup>1</sup> 1.03	<sup>5</sup> 5.15	<sup>64</sup> 65.93	<sup>21</sup> 21.65	<sup>6</sup> 6.19%	—	—
Quality of pulp	96	<sup>18</sup> 18.75	<sup>35</sup> 36.46	<sup>39</sup> 40.62	<sup>4</sup> 4.17	<sup>0</sup> 0%	—	—

TABLE 114.

MEASUREMENT OF 10 FRUITS OF OWARI FROM OWARI (REVERTED) BRANCHES  
OF MAMYÔ'S PLANTS AT ÔCHÔ IN 1920. (NOS. 1134, 1136, 1142, 1153,  
1164-1166, 1173-1175 FROM LOT NO. 4.)

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.17 cm.	3.91 cm.	1.40	62.00 gm.	9.70 mm.	10.50	2.30 mm.	11.35 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	10	—	—	—	—	—	0	% 0
Sinuate based fruits	10	—	—	—	—	—	4	40.00
Semi-sinuate based fruits	10	—	—	—	—	—	3	30.00
Areolated fruits	10	—	—	—	—	—	5	50.00
Frs. with undeveloped calyx lobes	10	—	—	—	—	—	5	50.00
Frs. with long narrow calyx lobes	10	—	—	—	—	—	0	0
Fruits containing seeds	10	—	—	—	—	—	0	0
Apical depression	10	2 20.00	6 60.00	2 20.00	0 0%	—	—	—
Apical dots	10	3 30.00	5 50.00	2 20.00%	—	—	—	—
Flatness of fruit	10	2 20.00	5 50.00	2 20.00	1 10.00	0 0%	—	—
Smoothness of fruit	10	9 90.00	1 10.00	0 0	0 0	0 0%	—	—
Thinness of rind	10	6 60.00	3 30.00	1 10.00	0 0	0 0%	—	—
Thinness of segment wall	10	10 100.00	0 0	0 0	0 0	0 0%	—	—
Color of pulp	10	0 0	6 60.00	4 40.00	0 0	0 0%	—	—
Size of central column	10	0 0	3 30.00	5 50.00	2 20.00	0 0%	—	—
Quantity of pith	10	0 0	1 10.00	8 80.00	1 10.00	0 0%	—	—
Quality of pulp	10	0 0	1 10.00	6 60.00	3 30.00	1 10.00%	—	—

to be Owari, unquestionably sprung up vegetatively from the Wase branch (PL. XLIX, Fig. 12). The ninth tree in the lower ground is Wase, but it has also an Owari branch undoubtedly sent forth from the Wase trunk (PL. XLIX, Fig. 13). The tenth tree is Wase, and no such freak was found. The result of this observation shows that evidently even the trees which came directly from the original plants behave like the trees of later generations in showing variability of this peculiar nature.

(2) An investigation of MIYAZAKI's plants at Furuyado and Kajiya, Tsukumi village was also made. Six large Wase trees at Furuyado, propagated by MIYAZAKI in 1895, the first time from KAWANO's plants, are located in the terrace orchard now belonging to Kajûrô ÔMURA. Four of them are found on the lower terrace, and the other two are grown on the upper terrace. The last tree is half Wase and half Owari, two buds being inserted originally on to the same stock. The central part of the Wase part of this plant is Owari, undoubtedly sent forth later from the Wase branch through vegetative reversion (PL. XLIX, Fig. 11).

Eight old Wase trees in the Kajiya orchard also came directly from KAWANO's original plants, being propagated by MIYAZAKI in 1895. These trees subsequently received the author's careful examination. The first tree in the uppermost row is a vigorous-looking tree with dense foliage and large fruits. One upright branch is suspected to be Owari, but this was not confirmed. The second Wase tree opposite the path on the same terrace, is a typical Wase throughout. The third Wase tree on the lower terrace has a compact head, dense foliage, and smaller, smooth fruits, but one branch on the south-west side, bearing one rough fruit, looks like Owari, but this also was not confirmed. The fourth tree on the lower terrace at the corner of the path is much covered by the upper trees but is decidedly Wase throughout. This is the first plant in which MIYAZAKI discovered the good, early-maturing nature of the crop as early as 1896. The fifth tree below is considerably small-sized, but is thoroughly Wase. The sixth tree on the lower terrace, opposite the path, is a slender tree of Wase bearing large Wase fruits. The seventh and eighth trees on a still lower terrace are good-looking Wase trees. In conclusion, these eight

trees do not seem to have any very conspicuous freak, although two of them are questionable.

(3) There are still more second generation trees from KAWANO's original plants, the bud sticks of which were taken in 1895 and later. These are eight plants belonging to Kôtarô SHIMOMURA, planted in a small orchard located along a brook. The first Wase tree has one Owari branch conspicuously. The second tree took two buds from the beginning, one being Wase, the other Owari; the third tree is also the same. The fourth tree is a Wase throughout, and the fifth Wase tree has an upper branch of Owari on its western trunk, arising from the Wase part. The sixth plant is thoroughly Wase, and the seventh has a very large Owari branch sent forth from the Wase trunk. The eighth tree is still more remarkable. It has one Owari trunk, originally budded as Owari, besides a Wase trunk which covers the larger part of the tree. This Wase trunk has a Wase branch down below and then an Owari limb; the trunk still remains Wase and sends forth Wase branches, especially one standing upright, and finally ends with a distinct Owari limb. In two places of the Wase trunk just below the position where the Owari limb commences, the surface has a conspicuous depression left as a sign of variation. Such depression is occasionally seen on either sporting or reverting shoots, and is supposed to have some connection with the variation.

(4) A small planting of third generation Wase trees from KAWANO's original trees, owned by the same person, was examined. There are fifty trees all intended to be Wase, but 16 were found thoroughly Owari. No Wase variation was found in 1920, when the plants were between six and eight years old; not big enough to show such variation. The crop of 1920 was also very poor so that no definite data was obtainable. This orchard is located at Nidenoki, near the place where the second generation trees are grown.

(5) Another planting of third generation trees from KAWANO's original trees is owned by Kajûrô ÔMURA, and is found on the same terrace orchard of Furuyado where the second generation plants are grown. There are 42 plants, all intended to be Wase, but 17 are Owari. Among

the remaining 25 Wase plants, 4 bear Owari branches arising from the Wase part through reversion. These trees were all propagated from MIYAZAKI'S second generation trees in 1899.

(6) In the orchard belonging to Ejûrô SHIMOMURA, the discoverer of the branch "mistake" of the Wase, there are found about 40 trees originally grafted from MIYAZAKI'S second generation trees at Furuyado. Ten trees were of such mistaken nature, bearing Owari branches, and such branches had all been removed by the owner before the writer made the investigation. He showed the writer a fresh wound on a Wase trunk, on which he recently discovered a mistaken shoot. Such branches had often been displayed by him for demonstrations at farmers' meetings, in order to warn others not to propagate such variations.

(7) Investigation was also made in 1920, in the orchard belonging to Sakutarô SAKAMURA, which has 195 trees of Citrus. A census of this orchard gave the following return.

1. Old Owari plants existing before the acquisition of the orchard ... ..	11
2. Old Ikeda plants existing before the acquisition of the orchard ... ..	9
3. Owari plants set in later, intending to obtain Owari ... ..	58
4. Kinokuni ... ..	3
5. Ikagi-mikan ( <i>Citrus succosa</i> HORT.) ... ..	8
6. Yatsushiro, from Wakayama Prefecture ... ..	2
7. Owari Satsuma, from Owari Province ... ..	1
8. Wase, young unbearing trees (2 on trifoliolate, 6 on Navel, 1 on Natsudaïdai)	9
9. Wase, intended to be Wase... ..	94

Among which :

(1) Wase bud correctly put in ... ..	61 cases
(2) Owari bud inserted instead of Wase (unintentionally) ... ..	37 cases
Total ... ..	98 cases

Among which :

(a) Two-bud trees, counted in cases ... ..	4
(b) Thoroughly Wase, including trees with two-buds ... ..	52
(c) Evidently reverting Wase, bearing Owari limb on ... ..	6
(d) Ambiguously reverting Wase ... ..	3

Percentage of evidently reverting Wase vs non-reverting Wase ... .. ca 10%

Percentage of reverting trees, including ambiguous ones ... .. 14. 75%

Percentage of Owari bud vs total buds intended to be Wase ... .. 37. 75%

(8) A similar survey was also conducted at Ôchô in 1920. The orchard of Tora DOI, propagated from ISHIDA's plants coming directly from Ôita Prefecture, has 17 trees grafted by ISHIDA himself. Seven of them bear both trunks of Wase and Owari, originally two kinds of buds were unintentionally inserted. Four trees were found to be thoroughly Owari and six were thoroughly Wase. The Wase part of one of the two-bud plants was found to bear an Owari limb. This gives altogether 10 Owari buds and 13 Wase buds, one of which is reverting, totaling 24 buds.

(9) Most extensive studies were carried out in a flat-land orchard, where observations could be more readily made than in hillside plantings.

An orchard belonging to Tôshirô HATSUMOTO at Midzunashi, already described before, was investigated thoroughly. There are six rows each on both sides of a path running east and west, and the southern plot runs down to the sea. There are 92 Satsuma plants and a few lemon trees. The buds all came from ISHIDA's trees taken from Ôita Prefecture. 50 plants were found to be Owari, and among the remaining 42 plants, 6 were reverting, having Owari limbs arising from the Wase part, and one was a two-bud tree also showing reversion in the Wase part. The same orchard was re-examined in 1924, and the writer found three more Wase plants showing reversion, which have apparently started variation since his first examination in 1920. The entire crop of reverting Wase plants were studied in 1924 and the result is given later.

(10) A field observation on a still larger scale was made in the orchard belonging to Jitsuzô ÔNO at Tsukura, Ôchô-mura, Toyoda-gun, Hiroshima-ken. 119 plants were carefully observed in 1920. A brief conclusion of the census is given below :

1. Total Owari plants, originally intended to be Wase ... ..	52
2. Two-buds plants, half Wase and half Owari ... ..	5
3. Injured tree, identified as a probable Owari ... ..	1
4. Thoroughly Wase plants (including 3 questionable cases) ... ..	42
5. Two-buds trees, showing reversion on Wase part... ..	2
6. Reverting Wase plants ... ..	13

Percentage of reverting Wase (15 buds out of 62 total Wase buds) ... ..	27. 19%
Percentage of reverting Wase from all buds (15 in 122) ... ..	12. 30%
Percentage of Owari buds from total buds (57 in 122) ... ..	46. 72%

In 1924 the same orchard was studied again to find out if the percentage of reversion remains constant or not. The census, however, brought in a very different result. 10 Wase plants which had no definite sign of reversion in 1920, showed reversion, and gave a great rise of the percentage of reverted Wase. The recount of the reversion data obtained in 1924 is given below :

1. Total Owari plants... ..	52
2. Two-buds plants, half thoroughly Wase and half Owari* ... ..	3
3. Imperfectly identified tree turned out to be Owari ... ..	1
4. Thoroughly Wase ... ..	37
5. Reverting Wase, including that occurring on two-buds trees ... ..	22

Among which :

(1) Trees known in 1920**... ..	11
(2) Trees newly discovered in 1924 ... ..	11
Grand total ... ..	115

Percentage of reverting Wase (22 out of 62 total Wase buds) ... ..	30. 64%
Percentage of reverting Wase to total buds (22 out of 118) ... ..	18. 64%
Percentage of Owari buds from total buds (53 out of 118) ... ..	41. 53%

(11) A very large orchard belonging to Mototarô ASAUMI at Kamano, Ôchô village, was first time investigated in 1924. The orchard is covered with beautiful-looking trees propagated in 1909 and 1911, bearing heavily with an excellent crop when studied on Oct. 4th and 5th, 1924. 106 trees from the highest part of the orchard were examined and the return of the survey is tabulated below :

1. Owari trees ... ..	32
2. Thoroughly Wase trees... ..	31
3. Two-buds trees, partly thoroughly Wase and partly Owari ... ..	4
4. Reverting Wase trees ... ..	39
Total ... ..	106

\* Owari part from three previously noted ones removed : 1 found new.

\*\* Owari part removed from 4 trees, therefore counted as Wase.

Percentage of Owari trees (36 out of 110 buds) ... ..	32. 72%
Percentage of total Wase trees (74 out of 110 buds) ... ..	67. 28%
Percentage of reverting Wase out of total Wase (39 out of 74 buds) ... ..	52. 70%

## INVESTIGATIONS ON FRUIT OF THE VARIATION- STUDY PLOTS

In connection with the study of variation of the Wase Satsuma, field observation is almost sufficient for making decisions of variety when the study is made at the proper time. When fruits of Wase and Owari are fully mature, the distinction between them is a little difficult unless the quantity of material is sufficient. When they are in an over-ripe condition, distinction is hard because the Wase fruit tends to become rough and to show a basal depression, and, moreover, the halved fruit often has a large central column and a baggy peel. The same condition also affects the Owari fruits which approach the Wase in character. The best time for such observation to give a satisfactory conclusion, is, therefore, just the time when the Wase fruit shows a considerable advance in color over the Owari. For this reason, the first and second weeks of October must be chosen for making such a study, because at this time the Wase fruit shows full smoothness and has bright colored spots on the surface, while the Owari fruit remains deep green, thoroughly pitted, and is under full size. In cases where the reverting shoot is not large enough and bears only one or two fruits, the judgement as to whether it is truly a reverting shoot or not becomes very difficult to make, since late-bloom Wase fruit might appear as Owari fruit.

In order to be absolutely sure of field judgement the crop must be harvested at the proper time and a careful comparison must be made in the laboratory. To confirm the accuracy of the field data obtained from HATSUMOTO's and ÔNO's orchards in 1924, fruits of certain reverted shoots were picked separately and sent to Fukuoka, where a careful examination was made. The following data gives the details of this study.



## (1) HATSUMOTO's orchard

The condition of the orchard in 1924 was not very good especially in the eastern plot near the water. Rust mite affection was wide spread and the leaves looked light-colored and somewhat curled. The scheme given below will show the exact location of the plants in both plots.

FIG. 1.

## PLOTS OF HATSUMOTO'S ORCHARD AT MIDZUNASHI, ÔCHÔ, HIROSHIMA-KEN.

*EAST PLOT* (Trees are numbered from the southernmost row eastward, running up to the next northern row, etc.)

1	7	13	18	23	28	33	38	42	45	47
O	O	O	W	R	O	R	W	O	W	W
2	8	14	19	24	29	34	39	43	46	—
O	O	W	O	(R)	O	W	O	W	O	—
3	9	15	20	25	30	35	40	44	—	—
O	O	O	O	R	O	O	O	W	—	—
4	10	16	21	26	31	36	41	—	—	—
W	O	W	O	W	O	O	W	—	—	—
5	11	17	22	27	32	37	—	—	—	—
W	O	O	W	W	O	W	—	—	—	—
6	12	—	—	—	—	—	—	—	—	—
W	W	—	—	—	—	—	—	—	—	—

*WEST PLOT* (Trees are numbered in the same way)

48	54	60	66	72	78	—	—	—
O	W	W	O	O	W	—	—	—
49	55	61	67	73	79	84	—	92
(R)	W	O	W	O	(R)	O	—	O
50	56	62	68	74	80	85	—	—
O	W	W	R	W	W	(R)	—	—
51	57	63	69	75	81	86	89	—
O	O	R	W	W	O	W	O	—
52	58	64	70	76	82	87	90	—
O	O	W	O	O	O	R	W	—
53	59	65	71	77	83	88	91	—
W	W	O	O	O	O	O	O	—

Remarks: O.....Owari plant. W.....Wase plant, without showing variation.

R.....Wase showing variation in 1920 and 1924.

(R).....Two bud tree, partly Wase and partly Owari from the beginning, but showing variation on Wase part.

(R).....Wase plant which did not show variation in 1920, but showed it in 1924.

The census of the plots is tabulated below :

Total number of trees ... ..	92
Owari plants ... ..	47
Wase plants, including a two-bud tree ... ..	45
Plants not showing variation ... ..	34
Plants showing variation ... ..	10
Variation found in 1920 ... ..	7
Variation found first in 1924 ... ..	3
Percentage of reverting buds out of total Wase buds (10 to 44) ... ..	22. 73%
Percentage of reverting buds out of total buds (10 to 93) ... ..	10. 75%
Percentage of Owari buds out of total buds (49 to 93) ... ..	53. 76%

### Details of reverting trees

**Tree No. 23.** (PL. XLIX, Fig. 14) A small limb 72 cm. from the ground reverting. Observations for two years agree\*. Four fruits (Nos. 9719-9722) were Wase, not Owari. This lot is supposed to have come from the reverted branch marked, but apparently was picked from a wrong branch nearby. The branch bearing the revealing limb is forked, one fork of which was Wase, according to a sketch made in 1920. In 1924 this point was overlooked and the whole branch was marked Owari. The fruit samples must have come from the Wase branch above mentioned.

**Tree No. 24.** (PL. XLIX, Fig. 15) Three trunks come out from the common root, one trunk of which is thoroughly Owari. This was originally destined to be a two-bud (or perhaps a three-bud) tree. The north-eastern branch on the northern trunk is reverting from a point about 30 cm. from the ground. The bottom of the reverting limb has several depressions on the bark. The full crop of the Wase part was studied and has been described previously (Lot No. 1 of 1920, Table 111). A large amount of the fruit borne on the reverting limb (Owari) was collected and worked out statistically. The data is given in Table 115, and the figures for the Owari part (one part of the two-bud trunk) are also given in Table 116.

**Tree No. 25.** (PL. XLIX, Fig. 16) Large upright plant, the uppermost branch being reverted. The observations for two years quite agree and the thick part of the reverting limb has many depressions on the surface. 105 fruits (Nos. 9539, 9549-9652) were examined and proved to be Owari. The measurements of these fruits are given in Table 117.

**Tree No. 33.** (PL. XLIX, Fig. 17) Medium-sized Wase plant, a small limb facing the path is reverting. The sketches from two years agree. This is a small limb but the depressed grooves are found on the bottom of the limb in question. Two samples of fruit

\* The observation made in 1924 was carried out without consulting the chart drawn in 1920, so that free judgement was given both times. Exact sketches of the tree made independently in both years are consulted here in giving the conclusion.

TABLE 115.

MEASUREMENT OF 85 FRUITS (NOS. 9463-9538, 9540-9548) FROM A REVERTING  
OWARI BRANCH OF TREE NO. 24 OF HATSUMOTO'S WASE ORCHARD  
AT MIDZUNASHI, ÔCHÔ VILLAGE.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.07 cm.	4.64 cm.	1.45	103.33 gm.	9.94 mm.	10.81	3.24 mm.	13.01 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	84	—	—	—	—	—	38	45.24
Sinuate based fruits	84	—	—	—	—	—	32	38.10
Semi-sinuate based fruits	84	—	—	—	—	—	16	16.67
Areolated fruits	84	—	—	—	—	—	61	72.62
Frs. with undeveloped calyx lobes	85	—	—	—	—	—	13	15.29
Frs. with long narrow calyx lobes	85	—	—	—	—	—	0	0
Fruits containing seeds	85	—	—	—	—	—	0	0
Apical depression	84	52 61.90	26 30.95	6 7.14	0 0%	—	—	—
Apical dots	82	5 6.10	48 58.54	29 35.37%	—	—	—	—
Flatness of fruit	8 5	26 30.59	29 34.12	21 24.71	6 7.06	3 3.53%	—	—
Smoothness of fruit	84	0 0	5 5.95	27 32.14	24 28.57	28 33.33%	—	—
Thinness of rind	85	5 5.88	18 21.18	42 49.41	17 20.00	3 3.53%	—	—
Thinness of segment wall	85	53 62.35	32 37.65	0 0	0 0	0 0%	—	—
Color of pulp	83	2 2.41	47 56.63	32 38.55	2 2.41	0 0%	—	—
Size of central column	85	3 3.53	13 15.29	44 51.76	22 25.88	3 3.53%	—	—
Quantity of pith	85	0 0	14 16.47	58 68.24	12 14.12	1 1.18%	—	—
Quality of pulp	51	15 29.41	26 50.98	10 19.61	0 0	0 0%	—	—

TABLE 116.

MEASUREMENT OF 119 FRUITS (NOS. 9344-9462) FROM OWARI TRUNK WHICH  
 ORIGINALLY CAME AS A TWO-BUD TREE, BEING TREE NO. 24 OF  
 HATSUMOTO'S WASE ORCHARD AT MIDZUNASHI, ÔCHÔ.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.88 cm.	4.39 cm.	1.46	88.11 gm.	10.45 mm.	10.04	2.90 mm.	11.04 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	110	—	—	—	—	—	11	% 10.00
Sinuate based fruits	112	—	—	—	—	—	65	58.04
Semi-sinuate based fruits	112	—	—	—	—	—	15	13.39
Areolated fruits	109	—	—	—	—	—	94	86.24
Frs. with undeveloped calyx lobes	115	—	—	—	—	—	14	12.17
Frs. with long narrow calyx lobes	115	—	—	—	—	—	0	0
Fruits containing seeds	117	—	—	—	—	—	0	0
Apical depression	109	65 59.63	33 30.28	11 10.09	0 0%	—	—	—
Apical dots	109	8 7.34	62 56.88	39 35.78%	—	—	—	—
Flatness of fruit	110	9 8.18	33 30.00	58 52.73	8 7.27	2 1.82%	—	—
Smoothness of fruit	110	0 0	27 24.55	65 59.09	16 14.55	2 1.82%	—	—
Thinness of rind	115	15 13.04	49 42.61	39 33.91	11 9.57	1 0.87%	—	—
Thinness of segment wall	115	100 86.96	15 13.04	0 0	0 0	0 0%	—	—
Color of pulp	114	57 50.00	38 33.33	16 14.04	2 1.75	1 0.88%	—	—
Size of central column	116	0 0	4 3.45	68 58.62	36 31.03	8 6.90%	—	—
Quantity of pith	116	0 0	5 4.31	76 65.52	33 28.45	2 1.72%	—	—
Quality of pulp	89	37 41.57	35 39.33	17 19.10	0 0	0 0%	—	—

TABLE 117.

MEASUREMENT OF 105 FRUITS (NOS. 9539, 9549-9652) FROM A REVERTING  
OWARI BRANCH OF TREE NO. 25 OF HATSUMOTO'S WASE ORCHARD  
AT MIDZUNASHI, ÔCHÔ, IN 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.19 cm.	4.35 cm.	1.50	137.98 gm.	9.58 mm.	10.61	3.00 mm.	13.69 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	97	—	—	—	—	—	33	34.02%
Sinuate based fruits	103	—	—	—	—	—	16	15.53
Semi-sinuate based fruits	103	—	—	—	—	—	8	7.77
Areolated fruits	94	—	—	—	—	—	83	88.30
Frs. with undeveloped calyx lobes	104	—	—	—	—	—	22	21.15
Frs. with long narrow calyx lobes	104	—	—	—	—	—	0	0
Fruits containing seeds	101	—	—	—	—	—	0	0
Apical depression	96	64 66.67	28 29.17	4 4.17	0 0%	—	—	—
Apical dots	96	15 15.62	68 70.82	13 13.54%	—	—	—	—
Flatness of fruit	96	18 18.75	33 34.38	34 35.42	10 10.41	1 1.04%	—	—
Smoothness of fruit	96	0 0	10 10.41	19 19.79	27 28.13	40 41.67%	—	—
Thinness of rind	101	4 3.96	48 42.57	44 43.56	8 7.92	2 1.98%	—	—
Thinness of segment wall	101	79 78.22	21 20.79	1 0.99	0 0	0 0%	—	—
Color of pulp	101	12 11.88	42 41.58	47 46.53	0 0	0 0%	—	—
Size of central column	101	9 8.91	32 31.69	45 44.55	13 12.87	2 1.98%	—	—
Quantity of pith	101	0 0	14 13.86	81 80.20	6 5.94	0 0%	—	—
Quality of pulp	49	12 24.49	16 32.65	21 42.86	0 0	0 0%	—	—

(Nos. 9725 and 9726) taken from this limb were over-ripe when they came, but looked like Owari.

**Tree No. 49.** (PL. XLIX, Fig. 18) Large Wase tree; eastern branch 88 cm. from the ground reverting. This was found in 1924. It is a small, more or less drooping branch. 6 fruits (Nos. 9731-9736) came and all were definitely Owari.

**Tree No. 63.** Wase tree with a dead part at the center. A low branch directed N-W and running horizontally for a while, has a reverting limb but had no fruit in 1924. Three fruits on the Wase part borne just above the reverting shoot were examined later and they were undoubtedly Wase.

**Tree No. 68.** (PL. XLIX, Fig. 19) Large tree, the south branch of which is Owari by reversion. The branch forms a large arch, and the reverting part starts at a point about 1.16 m. from the bottom of the trunk and 30 cm. from the ground. There were two fruits borne on a small adventitious bud arising just at the starting point of the Owari limb. These two fruits (Nos. 9762 and 9763) sent in later were definitely Wase, while 7 fruits (Nos. 9755-9761) taken from the reverting limb were thoroughly Owari.

**Tree No. 79.** (PL. XLIX, Fig. 20) Medium-large-sized Wase; a small branch on the east side about 90 cm. from the ground (1.45 m. from the bottom of the trunk) is reverting. All other parts have typical twisted Wase leaves. Three fruits (Nos. 9771-9773) sent later proved clearly to be Owari. This variation was not found in 1920.

**Tree No. 85.** (PL. XLIX, Fig. 21) Another newly discovered reverting tree of medium size, having a branch arising eastward at about 72 cm. from the ground. The bottom of the branch is considerably uneven, with undulate surface. 12 fruits (Nos. 9774-9785) sent from this branch were all definitely Owari.

**Tree No. 87.** (PL. XLIX, Fig. 22) The variation was discovered in 1920. This is the top of the central trunk "A" about 70 cm. from the ground. The point of variation is very clear. It has the usual mark of an undulate surface at the bottom where branch "A" starts. An adventitious shoot borne on "A" branch at a distance about 15 cm. from the beginning is decidedly Wase, judging from a fruit terminating this shoot. Four inches below the junction another adventitious shoot carrying fruits is also proved to be Wase, so that the Owari part starts just exactly at the junction where the "A" branch starts. Strangely enough, the terminal shoot of branch "A", the fifth shoot from the junction above mentioned, is supposed to have another reversion, and two fruits (Nos. 9803-9804) were collected from this shoot. At least one of them was definitely Owari, and the other was probably the same, not being definitely determinable because of over-maturity. 17 fruits coming from the first reverting part (Nos. 9786-9802) proved definitely to be Owari. This part was discovered to be Owari in 1920.

The terminal branch of another upright trunk marked "B", a little smaller than the trunk "A" but running almost parallel to it, was also suspected. The point of the supposed variation starts at a distance of about 1.5 m. from the ground. Five fruits (Nos. 9805-9809) were sent in, and they definitely proved to be Owari. This gives three indepen-

dent reversions taking place on the same plant. Curiously, these two trunks, one bearing a single variation, the other two, are united near the ground, but the remaining trunks spreading around the two upright "A" and "B" trunks have no sign of reversion. The disturbance, if the change is due to it, must be rooted at the center of the tree, going up both of the vigorous upright trunks. In the case of branch "A", it carries the reversion element in it notwithstanding that it shows Wase for a large area, and finally exposes the element thoroughly. A similar, but not identical, case is to be noticed later (Ôno's plant No. 48).

## (2) ÔNO's orchard.

This orchard is somewhat triangular in shape, and the majority of the plants are found on the low ground at sea level. The upper part of the orchard is on a slow inclination and stone terraces are built to prevent wash off. The crop looked to be 5 days in advance of HATSUMOTO's in 1924, and the condition of the trees was better, showing less dwarfing and less infection of rust mite. The orchard row runs from S-E to N-W in the bottom plot. On the slope the rows run almost from S to N. Every tree was marked from east to west beginning with the southernmost row. The result of the census in 1924, marked on the scheme is given in Fig. 2.

The last row (Tree Nos. 113-121) is a later planting and was not included in the figures used in comparing the return for 1920, previously given. Including these 9 plants, and bringing the total up to 124 (or 127 buds, counting the two-bud trees separately), the return will be as follows :

1. Total Owari plants...	51
2. Two-bud trees, one bearing reverting part	43
3. Thoroughly Wase; originally so, or Owari part cut down from two-bud trees and from some of the reverting plants: also including new planting	46
4. Reverting plants, remaining since 1920	11
5. Reverting plants, discovered in 1924, including one case in newly planted row	12
Total	124
Percentage of reverting Wase buds (24 out of 73 total Wase buds)	32. 88%
Percentage of reverting Wase buds to total buds (24 out of 127)	19. 42%
Percentage of Owari buds to total buds (54 out of 127)	43. 62%

### *Record of individual reverting trees*

**Tree No. 4.** (PL. L, Fig. 1) Medium-sized tree; a small branch on the eastern side reverting. Two fruits (Nos. 9664-9665) were picked from the branch and were verified as Owari. This reversion was discovered for the first time in 1924.

**Tree No. 5.** (PL. L, Fig. 2) Rather small tree, a southern branch reverting. It





has been so conspicuous since 1920 that no study of the fruit was necessary.\* The lower part of the reverting branch has conspicuous grooves on its surface.

**Tree No. 7.** (PL. L, Fig. 3) Large-sized tree, on which no variation was found in 1920, but three branches were found reverting in 1924. This is one of the most remarkable cases of the reversion of the Wase Satsuma. A western branch at 88 cm. from the ground is reverting, and 9 fruits (Nos. 9679-9687) on the branch studied later proved to be Owari. The second reverting branch is found on the southeastern side of the tree at about 40 cm. from the ground. 9 specimens of fruit (Nos. 9688-9696) showed themselves definitely to be Owari. Fruit No. 9690, looked like Wase but it was later found that the pulp vesicles were unquestionably Owari. The third reverting branch on the southern projecting trunk at 1.3 cm. from the ground was also verified by testing 6 fruits (Nos. 9697-9702) picked from this branch. The thickest part of the main branch bearing the first and third reverting limbs bears many scars at the bottom, showing that a number of adventitious shoots were removed. No other particular signs were found on any of the branches.

**Tree No. 8.** (PL. L, Fig. 4) Rather large tree which has fasciated main branches on a short common trunk. The southern branch is Owari but does not seem to be a two-bud tree. This branch forks at about 23 cm. from the bottom, both forks bearing Owari fruits. Specimens of fruit not taken. This was first noted in 1924.

**Tree No. 14.** (PL. L, Fig. 5) Medium-sized tree, very much fasciated at the bottom of the tree. A branch on the top of the northern trunk at 115 cm. from the ground is reverting. Two fruits (Nos. 9715-9716) from this branch proved to be Owari. This plant was thoroughly Wase in 1920.

**Tree No. 16.** (PL. L, Fig. 6) Large-sized tree, one of the south branches at 58 cm. from the ground is reverting. The irregular grooves on the lower part of the reverting branch are very conspicuous. No samples of fruit were taken.

**Tree No. 18.** (PL. L, Fig. 7) Two-bud tree, southern trunk being originally thoroughly Owari. Southern branch from 30 cm. above the ground is reverting and has depression marks on the lower part of the branch. It has been known since 1920, and no specimens of fruit were collected in 1924.

**Tree No. 24.** (PL. L, Fig. 8) Rather small-sized tree with fasciated trunks, a trunk running northward is reverting at a point 17 cm. from the ground, and 9 cm. from the center. This has been known since 1920 and no specimens were taken. The southern trunk is forked into two immediately after it separates from the main trunk. One branch on the southern division reverts at a point 30 cm. from the ground. Depressions on the bark near the bottom are conspicuous. The determination of two fruits (Nos. 9653 and 9654) was uncertain due to their over-ripe condition. Another branch on the top of the northern division of the same trunk, at 72 cm. from the ground, was suspected to be Owari. Nine fruits (Nos. 9655-9663) from it were like Wase, but were not definitely determinable on account of their over-ripe condition.

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\* 13 fruits (Nos. 9666-9678) were sent in and proved to be Owari except for Nos. 9672, which looked most like Wase. The cause of this mixture is unknown.

**Tree No. 33.** (PL. L, Fig. 9) It was a two-bud tree in 1920, but the Owari trunk was found entirely cut down from the bottom, leaving a very large mark on the surface. Another branch on the eastern side of the tree was reverting in 1920, but it was overlooked in 1924. Another small branch on the western trunk, at 88 cm. from the ground, appeared to be reverting in 1914; one sample of fruit (No. 9724) taken from it later proved it.

**Tree No. 37.** (PL. L, Fig. 10) Rather large-sized tree, an eastern branch 30 cm. from the ground is reverting, known since 1920. Another small branch on the southeastern branch 1.45 m. from the ground was suspected to be reverting, but no specimens of fruit came to verify the determination.

**Tree No. 42.** (PL. L, Fig. 11) Medium-large tree; a south branch 43 cm. from the ground has been definitely reverting since 1920. No samples of fruit were taken from it. The top of the southern branch at a height of 1.15 m. from the ground was suspected to be reverting in 1924, and 3 fruits (Nos. 9727-9729) were taken. The determination of these fruits were very uncertain, due to their over-ripe condition.

**Tree No. 44.** (PL. L, Fig. 12) A small tree, a forking branch on the main upright trunk is reverting at a point 43 cm. from the ground. It has been known since 1920 and no samples of fruit were taken.

**Tree No. 48.** (PL. L, Fig. 13) Rather large-sized tree, a thin south-western branch at 43 cm. from the ground appeared to be reverting. Fruits were extremely small but were not heavily pitted in October but no samples were taken. Leaves also different from other parts, being much larger in size. No Wase-like fruit was found on this branch, so that it was judged to be a case of reversion.

**Tree No. 51.** (PL. L, Fig. 14) Large tree, a west branch of the second division, at 88 cm. from the ground, is reverting, and then after 7 cm. the branch forks, the northern fork being Wase and the southern Owari. Both Owari branches have elongated grooves on the surface near the bottom. Two fruits (Nos. 9737 & 9738) from the first reverting branch were decidedly Owari, and another two fruits from the second (Nos. 9739 & 9740) were over-ripe and rough, but they were straight Owari when observed on tree in October. In 1920, these two branches were recorded as reverting, but a Wase limb in between was overlooked.

**Tree No. 53.** (PL. L, Fig. 15) Rather large tree, a branch from the south side of the tree running eastward, rather thick, upright and at 43 cm. from the ground is reverting. The branch is slightly but conspicuously grooved at the base. No fruit came from this tree. This variation has been known since 1920.

**Tree No. 57.** (PL. L, Fig. 16) Large-sized tree, also known as reverting since 1920. The trunk runs straight for 29 cm. then divides into three main branches, the western one of which forks at 43 cm. from the ground. The upper branch of this is Owari and the lower is Wase. The reverting branch is thick and greatly grooved at the base. No fruit was taken.

**Tree No. 64.** (PL. L, Fig. 17) Large tree, a thick, southern branch, 17 cm. from the ground, is reverting. No specimens of fruit were taken. It has been known since 1920.

**Tree No. 66.** (PL. L, Fig. 18) Large tree, one small branch facing the east was found to be reverting. Two fruits (Nos. 9753-9754) were received, the first was definitely Owari, and the latter was rather uncertain. This was not known in 1920.

**Tree No. 67.** (PL. L, Fig. 19) A rather large main branch, 20 cm. above the ground, is entirely Owari and has been known since 1920. This is not a two-bud tree, because the union between the trifoliate stock is clear down below. No fruit was sent for critical examination.

**Tree No. 74.** (PL. L, Fig. 20) Large tree, a western branch 1.15 m. from the ground is reverting. The grooves on the surface of the lower part of the branch are conspicuous. Seven fruits (Nos. 9764-9770) were examined, but as they were over-ripe, the determination was not certain. This was found in 1924, but was preliminarily suspected to be reverting in 1920.

**Tree. No. 76.** (PL. L, Fig. 21) Large tree, the south trunk is terminated by a reverting branch at 1 m. from the ground and has a very conspicuous grooving mark on the surface. The grooves continue about 58 cm. and the branch itself is somewhat contorted. No samples of fruit were taken.

**Tree No. 94.** (PL. L, Fig. 22) Medium-sized tree, the western branch of which is entirely Owari. It was thought to be thoroughly Wase in 1920. No sample of fruit was taken.

**Tree No. 99.** (PL. L, Fig. 23) Medium-large tree, the western trunk forks at 43 cm. from the ground, and the eastern upright branch is Wase while the western branch continues to be Wase until one small drooping Wase branch comes out, and then reverts entirely into Owari. This was first found in 1924. Samples of fruit were not taken.

**Tree No. 116.** (PL. L, Fig. 24, 24a, & 24b) Small-sized tree, but an interesting case of reversion. The trunk is very short, only about 8 cm. from the union, and four main branches come out from almost the same place. (1) The northern branch is perhaps the lowest, (2) the eastern and (3) the western branches are at the same height and of the same thickness, both being Wase: (4) the southern branch is smallest and is entirely Owari. A branchlet (a) arising from (1), is slightly thicker than (4), runs almost parallel to it and somewhat overwraps it. This is entirely Owari. Although these branches have different starting points, the distance between them is only 3 cm. and both have very conspicuous grooves on the surface, 72 cm. long in (a) and 29 cm. long in (4). It seems likely that the reversion element lies in the central part of the flat basin surrounded by the vase-like main branches, connecting these two branches through this basin. It is more difficult to suppose that the reversions are entirely of different origin, because these two shoots were possibly sent forth in the same year, and they lie so close to each other. Similar evidence was also available from tree Nos. 40 and 48 of ASAUMI'S orchard. Specimens of fruit were not taken because the variation was very clear. This tree was not studied in 1920.

## (3) ASAUMI's orchard.

This orchard was only studied once in 1924, but many cases of interesting variation were found. To avoid taking up too much space for such field records, only certain remarkable cases are reported.

**Tree No. 40.** (PL. L, Fig. 25 & 25a) Large tree with very short common trunk, on which 5 vase-like divisions on the main branches go out in four directions. (1) Thick N-W branch is Owari throughout, with very conspicuous grooves on the surface, running quite a long distance. (2) N-E branch and (3) S-W branch are Wase and are almost equal in size to (1). (4) is also a similar branch forking immediately at the bottom, E being Owari and S being Wase. These (1) and (4) S branches are continuous through a flat basin of the bottom of the vase-like main branches, just as in the case of Tree No. 116 of Ôno's orchard. It is easily supposed that the reversion element connects both branches through the flat basin of the leading branches.

**Tree No. 47.** (PL. L, Fig. 26) Large tree, with three leading branches on a very short common trunk. The south trunk continues Wase for about 58 cm. and suddenly becomes Owari, with conspicuous groove markings on the surface of the branch. The northern trunk also has similar marks at the bottom but it remains Wase for a long distance up to 72 cm. from the ground, where an upright shoot shows itself to be thoroughly Owari. A slight depression-mark is seen also on the lower part of this shoot.

**Tree No. 48.** (PL. L, Fig. 27) Large tree and the whole tree inclines toward the north. The trunk divides into three at about 23 cm. from the union, and the western leader has two thick upright branches starting almost at the same place, about 30 cm. from the union. The southern branch, nearer to the center, suddenly turns southward after running 12 cm. upward, and there gives rise to a small limb just at the corner of the turn made in keeping an upright direction. The limb is invariably Wase. This is the first case that a Wase shoot is found coming out from reverted Owari branch. In this case, it seems clear that the southern reverting branch is not thoroughly Owari, but presumably it still contains some Wase element in it and casts it out later after a length of 12 cm. The Owari branches arising at right angles from the somewhat prone Wase branch are unquestionably connected at the bottom, as in the case of No. 40 of this plot and of Tree No. 116 of Ôno's orchard, but the connection seems loose, leaving a space which allows the Wase element to come in and disclose itself in the form of an adventitious shoot where the branch makes an abrupt turn and allows such a bud to come out.

## THE CHARACTER OF FRUITS BORNE ON THE REVERTING BRANCHES

The character of fruits borne on the reverting branches of the Wase Satsuma is worth testing and it is interesting to see whether they keep

the character of the original variety or not. Tables 115 and 117 give the detailed figures for such fruits, while Table 116 presents an Owari of unknown origin. The comparison shows their exact similarity, although the whole material was examined after a long period of storage and it was almost impossible to make the quality test. It is generally believed in Ôchô, however, that the reverting Owari fruit generally has a good appearance, almost matching the fruit from trees coming from the nurseries of Owari and Idzumi Provinces. Many farmers in Ôchô are reluctant to cut down reverting branches, because the fruits are easily marketed and bring a fair return. On the other hand, these fruits are generally thick-skinned, very rough, and less intense in the sweetness of the pulp, despite their attractive look in size and flatness. Unquestionably their keeping quality is poor, and they are subject to attacks of blue mould on account of the porosity of the skin.

In the examination of the statistical figures, it is easily noticed that these fruits are extremely large in size and very flat (D/H index runs as high as 1.44-1.50), although appearing rather tall on account of the conical base. They have a smaller calyx, thick rind, and more or less large, open central column. Comparison of Tables 115 and 116 with Tables 110 and 111 (Wase fruits from the same tree No. 24 of HATSUMOTO's orchard), will readily show the profound difference between these two kinds of fruits borne on the same tree.\* The difference of the development of the navel in reverting fruits and those of two-bud trunks is possibly due to the difference of individuality, and does not mean much. The difference of the number of sinuate based fruits in trees No. 24 and 25 of HATSUMOTO's orchard is really not significant, because fruits much depressed at the base were predominating in the lot of tree No. 25 and were not counted as sinuate based ones. The size of the central column in the Owari fruits is rather under-estimated; perhaps the figures deserve to be moved up one column to the left, if comparison with Wase fruits is necessary. To the observer's eye, the standard is shifted if many fruits are examined from two lots entirely unlike.

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\* Since the year of the investigation and the time of maturity (picking time) are different, the figures are not approximate although the diversity is not very great.

## BOOK VI



## STUDIES IN BUD VARIATION OF THE SATSUMA ORANGE

### *I. The First Period of Discovery*

#### THE WASE SATSUMA ORIGINATED THROUGH BUD VARIATION

As early as 1914 SATÔ<sup>(101)</sup> wrote a note on a case of the origination of the Wase character through bud variation. After attributing to the original plants of Kawano Wase a case of bud variation, he writes:

"Another case of a sport of the Satsuma orange, which is said to have been called to the attention of Matsuji KUBOTA fifteen years ago, is represented by a change of the character of a single branch of the common Satsuma into the Wase. This plant is located on a terrace facing southward, in a very thick-planted orchard with insufficient penetration of sun-light. The branch in question, as is seen in the figure, arises from an upright trunk of the tree and spreads horizontally to the northern direction. The fruit borne on this branch is said to ripen earlier and its character is said to be exactly similar to the Wase Satsuma."

Apparently he did not see the fruit, although he was then the county agent in charge of horticultural work. He did not indicate the name of the owner of the plant, and this article remained entirely neglected for years\*. In 1916, ONDA<sup>(91)</sup> admits that the common Kawano Wase is a variety that "unquestionably came from the common Satsuma", but he did not venture to say its origin was a bud variation. In 1918, one of his staff obtained a graft of the supposed limb variation of the Satsuma orange and this was propagated at the Horticultural Station ground in Okitsu. The author had an opportunity of investigating the fruits from it and he proved that it was a new type of Wase\*\*. Prior to 1920 these evidences of the independent occurrence of the Wase character through bud variation were entirely unproved, due to the lack of close study. In 1920, the writer first made an attentive study of these plants supposed to have two different kinds of branches and obtained sufficient proof that

\* This strain of the Wase Satsuma was later named "Higuchi Wase" by the writer.

\*\* This strain of the Wase Satsuma was later named "Hozaki Wase" by the writer.



these are clear cases of bud variation. The result of the investigations is given in the following chapters.

### HIGUCHI'S BUD VARIATION WASE SATSUMA AT TSUKUMI

On May 13, 1920, the writer was for the first time taken by Mr. MIYAZAKI to the plant mentioned by SATÔ, which was just blooming. This plant had been known to MIYAZAKI for a very long time, since he first propagated KAWANO's Wase plants. He admitted that this plant was yielding practically identical fruits. The owner, Sentarô HIGUCHI, told the writer that his father, Komakichi HIGUCHI, had known this branch for already 20 years. The tree is on a terrace orchard, spreading to one side, and the trunk is upright for about 60 cm. and then is forked into two large branches. The larger one, at about 90 cm. from the ground, has a horizontal branch about 1.5 m. long, and this branch corresponds to the bud variation branch sketched by SATÔ. The flowers borne on this branch were carefully examined and it was determined that they are absolutely identical to Wase. Flowers on this branch are decidedly larger and bloom earlier than those on the other branches. The flower buds of the former just before opening are broad, not slender as are the latter. The difference is exactly the same as that existing between the common Kawano Wase and Owari, as was studied at Ôchô, just before. The leaves on this particular branch seemed to be a little smaller at that time but were most essentially different in shape and in their drooping nature. Three plants propagated from this branch were also observed. Two of them were in a bad condition, having no flowers, and the leaves were also very few, having been shed off before. The third plant was normal and was bearing typical large flowers. The leaves on this plant seemed to be broader and lighter in color, almost similar to Kawano Wase. The owner mentioned that the plant had been propagated 8 years ago. It was 90 cm. in spread and 1.2 m. in height at this time.

On Oct. 13, 1920, when the tree was bearing a heavy crop, this individual was again investigated. The following note was taken in the orchard at the time.

The orchard is at Furuyado, Nishinouchi, Tsukumi-mura, Kitaamabegun, Ôita-ken. The site of the orchard is on a very steep hill facing toward S-S-W. Tree location: 5th terrace from the bottom, 6th tree to east. Trees are planted at distances of 3.5 m. The plant in question (PL. LI, Fig. 1) has a spread in the E-W direction of 4.35 m., that of N-S 2.6 m., and a height of 3.5 m. It was planted by Komakichi HIGUCHI about 30 years ago, being top-worked on a previously set large trifoliate stock. The bud of the plant came from a huge tree now dead, nearly 100 years old, found at Noborio, in the same village. The propagator remembers that the plant bore uniformly large, flat fruit. Overgrown by other trees closely planted on the sides, the present tree looks unhealthy, not showing a strong growth, and the sporting branch is said to have been of very slow growth for many years, although it used to produce a very beautiful crop every year. The leaves are small in every part of the tree, but those on the sporting branch are particularly so, and are much lighter in color. The soil is a loam with small pebbles, and is rich in organic matter, being mulched with straw, and well fertilized. No pruning is practiced.

The second generation plant (PL. LI, Fig. 2), from which a note on flowers was taken, was also studied thoroughly, and the following description was given on Oct. 16, 1920.

The orchard is at Nishikawachi, on a moderate slope facing the S-E direction. The tree is located in the second row above an old planting, south of a closed thicket, and stands between Kawano Wase plants at distances of 2.8 m. from the eastern and 2 m. from the western individuals. It is eight years old since being top-worked on a 3 years old trifoliate stock, has an E-W spread of 1.75 m., N-S spread of 1.5 m., and a height of 1.5 m. It is a spreading, open-headed tree with divergent trunks forked low. Branches few in number, rather straight, moderately loaded with fruits. Leaves are all small and twisted, with broad but acute apex; the internode between the leaves being very short. This plant has smaller leaves than its sister trees planted in the upper row, which have leaves almost as large as those of the Kawano Wase. The soil is loam with much sharp-angled gravel and is poor in organic matter. It is mulched

with straw, and fertilized with 1.5 shô (2.7 litres) of bean cake. No pruning is practiced.

The total crop of 26 fruits from the original sporting branch was harvested on Nov. 8, 1920 and was sent to Suma for investigation. The fruits are all large-sized and medium flat and very smooth, notwithstanding a comparatively heavy infection of sour scab. Oil cell dots are particularly large and deep-colored, deeper than the surrounding portions. Color of fruit is not intense, leaving many pale green areas. Apex of the fruit is very flat and the absence of dots around the styler point, together with the presence of an areola, is very common, but not predominating. Base is also flat, not sinuous around the calyx, but in many cases the margin of the disk is sunken, showing a very acute demarcation. Calyx is large and the body part is well developed, but some of the fruit has poorly developed lobes. Disk is large, but is often covered by large calyx lobes. Navel fairly well developed.

The halved fruits have generally a thin rind and some are really thin, but the segment wall is rather thick, and the central column is small and full of pith. Pulp is very meaty and solid, and the vesicles are arranged in salmon-flesh structures, also much similar in color. When eaten, the meat is crisp, not melting, although it contains plenty of juice. Taste is not intensely sweet and is more or less insipid, not of good quality probably due to the neglected condition of the plant.

It can be easily seen that the general character given above quite agrees with that of the Kawano Wase, and evidently this presents a proof that the Wase character can be originated through bud variation without any reference to the plants already in existence. This also brings us to a safe deduction that the common Kawano Wase must have originated through a similar process.

31 fruits from one of the second generation trees given above were also presented for study. Their description follows:

The size is smaller than the previous lot, ranging from medium to small, and the shape is of medium grade, slightly taller than the former. Surface is more rough and the green color is deeper. Flatness of apex and other characteristics are just the same, but the depression of the base

is deeper and is somewhat crater-like. A certain number of calyxes have well developed lobes looking like those of Tachibana (*Citrus tachibana* TANAKA), but are not elongated, perhaps lying on the due course of elongation. Navel mark is very prominent. Sour scab is also bad in this lot.

Halved fruits have thicker rind and thicker segment wall. Pulp characters are also the same as above, but the distinctness of the vesiculation is less in degree. Juice is more abundant than the former and the quality of pulp is about the same. The abnormality of the base, the thick rind and segment wall, are all possibly due to the poor condition of the tree, but the similarity of the fruit is unquestionable. It is, therefore, without doubt that the new character can be perpetuated through vegetative reproduction. The statistical figures of the measurements of fruits of both lots are given in Table 118 and 119.

The statistical figures show that both lots are very similar to each other and definitely prove the above given conclusion that the new Wase character is propagated safely by vegetative reproduction.

Both lots should naturally have a thinner skin if they did not have a severe infection of sour scab. The thickness of the segment wall and the large quantity of pith in the center is partly due to the same reason, but it is also more or less its natural character, since later studies showed the prevalence of this same character throughout other Wase strains. The nature of the undeveloped calyx lobes and the comparative few fruits with a naked apex, seems also one of its specialities.

Although this study gave the conclusive result that the characters of the fruit of the original branch of HIGUCHI's plant and of its second generation tree agree very closely to those of Kawano Wase studied the same year (Tables 94, 110, and 111), repeated study was needed to find out the real quality of fruit grown under healthier conditions. For this purpose these two plants were re-examined again 1924 and 1926. The observation made of the fruits in the crop of the original branch and those of the second generation trees in 1924, is as follows.

14 fruits (Nos. 9191-9204) from HIGUCHI's original bud variation branch, studied during Jan. 7-9, 1924. Fruits are very large to medium,

TABLE 118.

MEASUREMENT OF 26 FRUITS (NOS. 768-793) FROM HIGUCHI'S BUD VARIATION  
BRANCH (HIGUCHI WASE) OF AN OWARI TREE, AT TSUKUMI,  
ÔITA-KEN. LOT NO. 21 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.91 cm.	5.09 cm.	1.37	130.19 gm.	12.38 mm.	10.35	2.41 mm.	12.50 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	26	—	—	—	—	—	14	53.85%
Sinuate based fruits	26	—	—	—	—	—	0	0
Semi-sinuate based fruits	26	—	—	—	—	—	0	0
Areolated fruits	26	—	—	—	—	—	15	57.69
Frs. with undeveloped calyx lobes	26	—	—	—	—	—	7	26.92
Frs. with long narrow calyx lobes	26	—	—	—	—	—	0	0
Fruits containing seeds	26	—	—	—	—	—	0	0
Apical depression	26	0 0	0 0	10 38.46	16 61.54%	—	—	—
Apical dots	26	7 26.92	17 65.38	2 7.69%	—	—	—	—
Flatness of fruit	26	2 7.69	13 50.00	10 38.46	1 3.85	0 0%	—	—
Smoothness of fruit	26	26 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of rind	26	19 73.08	6 23.08	1 3.85	0 0	0 0%	—	—
Thinness of segment wall	26	1 3.85	14 53.85	8 30.77	3 11.53	0 0%	—	—
Color of pulp	26	4 15.38	11 42.31	11 42.31	0 0	0 0%	—	—
Size of central column	26	0 0	0 0	6 23.08	12 46.15	8 30.77%	—	—
Quantity of pith	26	7 26.92	18 69.23	1 3.85	0 0	0 0%	—	—
Quality of pulp	26	1 3.85	8 30.77	14 53.85	3 11.53	0 0%	—	—

TABLE 119.

MEASUREMENT OF 31 FRUITS (NOS. 794-824) OF A SECOND GENERATION TREE  
(NO. 1) OF HIGUCHI'S BUD VARIATION WASE SATSUMA  
(HIGUCHI WASE). LOT NO. 22 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.14 cm.	4.61 cm.	1.39	89.29 gm.	10.33 mm.	10.13	2.63 mm.	10.76 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	31	—	—	—	—	—	21	67.74%
Sinuate based fruits	31	—	—	—	—	—	0	0
Semi-sinuate based fruits	31	—	—	—	—	—	0	0
Areolated fruits	31	—	—	—	—	—	21	67.74
Frs. with undeveloped calyx lobes	27	—	—	—	—	—	13	48.15
Frs. with long narrow calyx lobes	27	—	—	—	—	—	0	0
Fruits containing seeds	31	—	—	—	—	—	0	0
Apical depression	31	0 0	0 0	21 67.74	10 32.25%	—	—	—
Apical dots	31	10 32.25	12 38.71	9 29.03%	—	—	—	—
Flatness of fruit	31	0 0	4 12.90	25 80.65	2 6.45	0 0%	—	—
Smoothness of fruit	31	4 12.90	22 70.97	5 16.13	0 0	0 0%	—	—
Thinness of rind	31	14 45.16	7 22.58	9 29.03	1 3.23	0 0%	—	—
Thinness of segment wall	31	7 22.58	13 41.74	6 19.35	3 9.68	2 6.45%	—	—
Color of pulp	31	0 0	6 19.35	24 77.42	1 3.23	0 0%	—	—
Size of central column	31	0 0	0 0	9 29.03	12 38.71	10 32.25%	—	—
Quantity of pith	31	7 22.58	18 58.06	6 19.35	0 0	0 0%	—	—
Quality of pulp	31	1 3.23	4 12.90	19 61.29	7 22.53	0 0%	—	—

appearance like the Kawano Wase, ranging from tall to flat, average medium in flatness but appearing taller and rectangular. Apex is rather flattened, not very concave, dots many, reaching to the styler point, except in No. 9202, which has a naked apex. Navel usually not prominent; areola usually not present. Base generally more or less rounded, stem-end only shallowly concave, rarely somewhat sinuous. Calyx not large, lobes often becoming thin, sepal-like and short-triangular. Stem usually thick. Surface even, almost no fovea, oil cell dots very prominent, often rough through sometimes quite smooth average well-colored, though frequently greenish. Somewhat scabby in certain fruits but not severe, some are russet due to mite affection. Color beautiful orange.

In cross-section the rind is thin, with more or less solid texture and large oil cells, the central column medium or slightly large; some have small center. Pulp rather deep-colored, meaty, juice vesicles very large and become solid in drying; taste sweet and more or less insipid, but not deteriorating, and some fruits are more or less subacid, due to being over-ripe, which changes the flavor.

8 fruit (Nos. 9205-9212) from No. 1 second generation tree, studied Jan. 8-9, 1924.

Fruit medium to very small in size, rather flat and smooth. Apex mostly concave, somewhat deeper, dots usually few but not absolutely lacking around the styler point. Navel present or absent, not very prominent, areola not pronounced. Base simply flattened, not grooved, striation (radial arrangement of oil cells in streaks) often clear; disk either developed or not so much so, average flattened and confluent with the surrounding portion of the peel. Calyx rather normal, sometimes with elongated narrow lobes. Oil cell dots large, close, convex or nearly even, often much polished (in small fruits), rarely roughened (No. 9205). Rather well colored, scabby in the two largest fruits.

Cross-section rather thin-rinded, as compared with fruits of the original branch, but more or less solid, and also with central column more pithy and larger. Segment wall also more or less thick, except in the

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\* PL. XXIV, Fig. 1.

\*\* PL. XXIV, Fig. 2.

two smallest fruits. Pulp rather juicy and deep-colored, tasting either good or medium-good, but rather poor in quality, though not deteriorating.

6 fruits (Nos. 9213-9218) from No. 2 second generation tree, studied Jan. 8-9, 1924.

Fruit large to medium in size, conspicuously flat like some Owari fruit. Apex broadly flattened, shallowly concave, dots usually reaching to the styler point, areola not noticeable. Navels all prominent. Base quite flattened (except No. 9213, which is half sinuous), fine striations present, disk not broad but flattened and often confluent with the surrounding portion of the rind. Calyx normal. Surface usually even or slightly harsh, sometimes quite smooth; oil cell dots prominent but in large fruits they are slightly pitted. Rather well colored and of good appearance.

Cross-section is about equal to that of No. 1 given above, but without extra small ones and is much better in quality. Rind medium-thin, but softer, pulp also softer, wall not thin but softer; pulp vesicles slightly finer, good quality and deeply colored. Central column large in some fruit; generally pithy.

The measurements of fruits of these three lots (Nos. 143, 144, and 145) are given in Tables 120,\* 121,\*\* and 122.\*\*\*

The remarkable flatness of the fruits of the No. 2 second generation tree is particularly interesting. This tree was not examined but is perhaps one of the trees seen before, which was not bearing in 1920. At any rate, this strain looks flatter than Kawano Wase fruits, but of course flat fruiting individuals exist also in Kawano Wase.

The study done in 1926 revealed a very satisfactory result about the real quality of this bud variation Wase Satsuma. The record of observation of the crops of the original branch and of one of the second generation trees is as follows:

20 fruits (Nos. 10689-10708) from HIGUCHI's original bud variation limb, studied Dec. 2-26, 1926.

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\* PL. XXIV, Fig. 3.

\*\* PL. XXIV, Fig. 4.

\*\*\*PL. XXV, Fig. 1.



TABLE 120.

MEASUREMENT OF 14 FRUITS (NOS. 9191-9204) FROM HIGUCHI'S ORIGINAL  
BUD VARIATION WASE SATSUMA BRANCH OF OWARI SATSUMA  
AT TSUKUMI LOT NO. 120 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
25.12 cm.	5.88 mm.	1.38	196.80 gm.	10.50 mm.	10.80	3.48 mm.	15.40 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	14	—	—	—	—	—	8	57.14%
Sinuate based fruits	14	—	—	—	—	—	1	7.14
Semi-sinuate based fruits	14	—	—	—	—	—	0	0
Areolated fruits	14	—	—	—	—	—	3	21.43
Frs. with undeveloped calyx lobes	14	—	—	—	—	—	3	21.43
Frs. with long narrow calyx lobes	14	—	—	—	—	—	0	0
Fruits containing seeds	14	—	—	—	—	—	1	7.14
Apical depression	14	0 0	3 21.43	10 71.43	1 7.14%	—	—	—
Apical dots	14	1 7.14	9 64.29	4 28.57%	—	—	—	—
Flatness of fruit	14	3 21.43	5 35.71	3 21.43	3 21.43	0 0%	—	—
Smoothness of fruit	14	2 14.29	7 50.00	5 35.71	0 0	0 0%	—	—
Thinness of rind	14	1 7.14	5 35.71	8 57.14	0 0	0 0%	—	—
Thinness of segment wall	14	0 0	2 14.29	9 64.29	3 21.43	0 0%	—	—
Color of pulp	14	11 78.57	3 21.43	0 0	0 0	0 0%	—	—
Size of central column	14	1 7.14	3 21.43	7 50.00	3 21.43	0 0%	—	—
Quantity of pith	14	0 0	13 92.86	1 7.14	0 0	0 0%	—	—
Quality of pulp	14	12 85.71	2 14.29	0 0	0 0	0 0%	—	—

TABLE 121.

MEASUREMENT OF 8 FRUITS (NOS. 9205-9212) OF NO. 1 SECOND GENERATION  
TREE OF HIGUCHI'S BUD VARIATION WASE SATSUMA (HIGUCHI  
WASE) AT TSUKUMI. LOT NO. 121 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.75 cm.	4.30 cm.	1.39	85.63 gm.	11.25 mm	10.63	2.38 mm.	12.63 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	8	—	—	—	—	—	4	% 50.00
Sinuate based fruits	8	—	—	—	—	—	0	0
Semi-sinuate based fruits	8	—	—	—	—	—	0	0
Areolated fruits	8	—	—	—	—	—	3	37.50
Frs. with undeveloped calyx lobes	8	—	—	—	—	—	1	12.50
Frs. with long narrow calyx lobes	8	—	—	—	—	—	2	25.00
Fruits containing seeds	8	—	—	—	—	—	0	0
Apical depression	8	0 0	6 75.00	2 25.00	0 0%	—	—	—
Apical dots	8	3 37.50	4 50.00	1 12.50%	—	—	—	—
Flatness of fruit	8	4 50.00	2 25.00	2 25.00	0 0	0 0%	—	—
Smoothness of fruit	8	6 75.00	1 12.50	1 12.50	0 0	0 0%	—	—
Thinness of rind	8	6 75.00	1 12.50	0 0	1 12.50	0 0%	—	—
Thinness of segment wall	8	4 50.00	2 25.00	1 12.50	1 12.50	0 0%	—	—
Color of pulp	8	8 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	8	1 12.50	3 37.50	3 37.50	1 12.50	0 0%	—	—
Quantity of pith	8	0 0	4 50.00	3 37.50	1 12.50	0 0%	—	—
Quality of pulp	8	3 37.50	3 37.50	2 25.00	0 0	0 0%	—	—

TABLE 122.

MEASUREMENT OF 7 FRUITS (NOS. 9213-9219) OF NO. 2 SECOND GENERATION  
TREE OF HIGUCHI'S BUD VARIATION WASE SATSUMA (HIGUCHI  
WASE) AT TSUKUMI. LOT NO. 122 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.24 cm.	4.63 cm.	1.46	97.86 gm.	11.23 mm.	11.00	2.57 mm.	14.64 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	7	—	—	—	—	—	7	100.00
Sinuate based fruits	7	—	—	—	—	—	0	0
Semi-sinuate based fruits	7	—	—	—	—	—	0	0
Areolated fruits	7	—	—	—	—	—	2	28.57
Frs. with undeveloped calyx lobes	7	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	7	—	—	—	—	—	0	0
Fruits containing seeds	7	—	—	—	—	—	0	0
Apical depression	7	0 0	7 100.00	0 0	0 0%	—	—	—
Apical dots	7	1 14.29	5 71.43	1 14.29%	—	—	—	—
Flatness of fruit	7	7 100.00	0 0	0 0	0 0	0 0%	—	—
Smoothness of fruit	7	1 14.29	4 57.14	2 28.57	0 0	0 0%	—	—
Thinness of rind	7	3 42.86	4 57.14	0 0	0 0	0 0%	—	—
Thinness of segment wall	7	2 28.57	3 42.86	1 14.29	1 14.29	0 0%	—	—
Color of pulp	7	7 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	7	0 0	4 57.14	3 42.86	0 0	0 0%	—	—
Quantity of pith	7	0 0	2 28.57	5 71.43	0 0	0 0%	—	—
Quality of pulp	7	6 85.71	1 14.29	0 0	0 0	0 0%	—	—

Most beautiful orange of thoroughly Wase type. Size large, even the smallest one is fairly good-sized, but extra large ones do not exist; well graded. Outline roundish but the side view shows that none of them is really extra-flat. All well and smoothly rounded at base (No. 10699 has slightly conical appearance), not concave at the stem-end (No. 10705 has rather broadly flattened and naked area around the calyx), generally slightly raised at the calyx or slightly depressed, and no large grooves present; fine radial striations are conspicuous but the disk ring is not exceedingly large and is slightly raised. Calyx moderately large but not very large, in some cases the lobes are poorly developed, none narrowly lobed. Stem usually small in comparison with the size of the fruit. Apex of fruit simply flat, only slightly concave, often with large naked area around the styler point. Navel generally closed. Surface beautifully orange-colored, smooth, with distinct, raised oil cell dots.

Section of three largest fruits (Nos. 10689-10691), Remarkable looking. Rind comparatively thin, wall medium-thick, central column medium-small, pith rather much but not too much in quantity, pulp deep-colored, very coarse grained and meaty, only some exceptional vesicles are whitened in rough fruit (No. 10691). Pulp soft and sweet, really excellent in quality, possibly the best that can be expected in the Satsuma orange.

Section of average fruits has thin rind (except No. 10693) and its texture is soft and elastic. The central column is uniformly small, segments rather few and their wall uniformly medium-thin (especially at the inner part). Pulp equally very deep-colored, meaty and extremely sweet, not insipid, very good quality. Pulp vesicles extremely large, coarsely netted, never whitened, with thin, often not visible, vesicle wall.

After storage, rind did not become detached from the pulp ball and the flavor did not change except by a slight loss of sugar.

2 fruits (Nos. 10709-10710) from one of the second generation trees, studied on Dec. 26, 1926.

Fruits large, medium globose, strongly pitted and strongly double-ringed around the calyx. Calyx well lobed, both with elongated narrow lobes. Disk completely flattened and confluent with the surrounding

TABLE 123.

MEASUREMENT OF 20 FRUITS (NOS. 10689-10708) OF HIGUCHI'S BUD VARIATION  
WASE SATSUMA ORANGE (HIGUCHI WASE) TAKEN FROM  
ORIGINAL LIMB LOT NO. 183 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.91 cm.	5.53 cm.	1.32	153.05 gm.	11.15 mm.	10.70	2.69 mm.	12.65 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	20	—	—	—	—	—	1	% 5.00
Sinuate based fruits	20	—	—	—	—	—	0	0
Semi-sinuate based fruits	20	—	—	—	—	—	0	0
Areolated fruits	20	—	—	—	—	—	6	30.00
Frs. with undeveloped calyx lobes	20	—	—	—	—	—	2	10.00
Frs. with long narrow calyx lobes	20	—	—	—	—	—	0	0
Fruits containing seeds	20	—	—	—	—	—	0	0
Apical depression	20	0 0	0 0	16 80.00	4 20.00%	—	—	—
Apical dots	20	12 60.00	7 35.00	1 5.00%	—	—	—	—
Flatness of fruit	20	0 0	6 30.00	9 45.00	4 20.00	1 5.00%	—	—
Smoothness of fruit	20	8 40.00	12 60.00	0 0	0 0	0 0%	—	—
Thinness of rind	20	17 85.00	2 10.00	1 5.00	0 0	0 0%	—	—
Thinness of segment wall	20	8 40.00	9 45.00	3 15.00	0 0	0 0%	—	—
Color of pulp	20	19 95.00	1 5.00	0 0	0 0	0 0%	—	—
Size of central column	20	0 0	0 0	9 45.00	11 55.00	0 0%	—	—
Quantity of pith	20	0 0	4 20.00	16 80.00	0 0	0 0%	—	—
Quality of pulp	20	19 95.00	1 5.00	0 0	0 0	0 0%	—	—

portion of the rind. Stem thick, more or less strongly radial-grooved. Apex broadly shallow concave. Navel present or absent; areolated or not areolated. Oil cell dots large and convex at the apex. Beautiful orange, but rougher than the average for the fruits of the original tree, probably due to the small crop.

In cross-section, rind is thin, wall medium or medium-thin; central column rather small and pith not very abundant. Pulp very deep-colored, very coarse grained, sweet and of good quality, meaty, no change of flavor after a storage of more than a month. Segments rather irregular in size, vesiculation coarsely netted, very attractive.

General character agrees with the fruit of the original tree in size, shape, and quality of fruit, which shows that no appreciable change has taken place through vegetative propagation.

Measurements of these lots (Nos. 138 and 184) are given in Tables 123\* and 124.

TABLE 124.

MEASUREMENT OF 2 FRUITS (NOS. 10709-10710) OF ONE OF THE SECOND  
GENERATION TREES OF HIGUCHI'S BUD VARIATION WASE  
SATSUMA (HIGUCHI WASE) AT TSUKUMI.  
LOT NO. 184 OF 1926.\*

Av. Girth	Av. height	D/H Index	Weight	Calyx	No. Segm'ts.	Rind.	Center	Seed
24.85 cm.	5.90 cm.	1.34	gm. 183.00	mm. 11.15	11.00	3.25 mm.	11.25 mm.	0

\* One fruit navelled, the other not. Both medium-flat (grade 2). Surface of both harshed (grade 3). Rind thin in one fruit, medium-thin in the other. Wall, one medium, the other medium-thin. Central column, one medium-small, the other medium. Pith one medium-much, the other medium. Quality of both, good.

Evidently the final study brought to the light the true nature of this Wase Satsuma of bud variation origin. The most characteristic feature of this strain is the flatness of the fruit and the good quality of the pulp. Other morphological characters observed during previous years hold good in the study of this year, with the exception of the presence of dotting around the stylar joint. The lack of oil cell dots at the stylar end, is, at any rate, a common character of the Wase; but this

\* PL. XXV, Fig. 2.

sometimes does not develop, as in the case of this Wase in previous years.

In conclusion, this is a remarkable strain with excellent fruits which are worthy of note when the condition of the tree is normal and the tree is well cared for. The writer is indebted to the owner of this Wase Satsuma, Mr. Sentarô HIGUCHI who took the trouble of caring for this plant so as to present creditable data for the writer's investigation.

### INVESTIGATION OF THE OWARI FRUITS OF HIGUCHI'S SPORT PLANT

It will be of great interest to know what kind of fruit is borne on the normal part of HIGUCHI's bud variation plant. The examination of the total crop of Owari fruits of this tree was made in 1920. The description of fruits received is given below.

74 fruits (Nos. 6160-6233) of HIGUCHI's Owari plant which bears a sport branch giving rise to the HIGUCHI Wase.

Total fruits: size medium-large, ranging from large to medium-small; shape medium-flat, outline very regular, shoulder rounded. Rind texture elastic, surface even, deep-colored, glazed, oil cell dots convex or concave. Stem-end flat to sinuous, with strongly sunken disk margin; no real grooves. Calyx medium-sized, lobes rather well developed, thick and deep green. Navel not prominent but it exists in many fruits. Areola generally distinct but not very strong. Tight-skinned and compact, not puffy or undulate.

Fruits were fully mature when examined, all were well colored but scab infection was rather severe, tending to make the rind dry soon.

The measurements of fruit of this lot (No. 23 of 1920) are given in Table 125.\*

In comparing this with Table 118, which gives the data of Wase fruits of the same plant, a big difference will readily be seen. While the fruit is much smaller, its flatness is very pronounced, with a thicker and rougher rind and large central column. Smaller calyx and

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\* PL. XXV, Fig. 3.

TABLE 125.

MEASUREMENT OF 74 FRUITS (NOS. 6160-6233) OF NORMAL PART (OWARI) OF  
HIGUCHI'S BUD VARIATION TREE AT TSUKUMI, ÔITA-KEN.

LOT NO. 23 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.68 cm.	4.44 cm.	1.41	92.78 gm.	10.15 mm.	10.69	2.68 mm.	13.47 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	74	—	—	—	—	—	24	% 32.43
Sinuate based fruits	74	—	—	—	—	—	29	39.19
Semi-sinuate based fruits	74	—	—	—	—	—	1	1.35
Areolated fruits	74	—	—	—	—	—	41	55.41
Frs. with undeveloped calyx lobes	74	—	—	—	—	—	10	13.51
Frs. with long narrow calyx lobes	74	—	—	—	—	—	6	8.11
Fruits containing seeds	74	—	—	—	—	—	11	14.86
Apical depression	74	0 0	2 2.70	55 74.32	17 22.97%	—	—	—
Apical dots	73	0 0	17 23.29	56 76.71%	—	—	—	—
Flatness of fruit	74	8 10.81	41 55.41	24 32.43	1 1.35	0 0%	—	—
Smoothness of fruit	74	2 2.70	35 47.30	27 36.49	10 13.51	0 0%	—	—
Thinness of rind	74	36 48.65	27 36.49	9 12.16	2 2.70	0 0%	—	—
Thinness of segment wall	74	14 18.92	23 31.08	33 44.59	4 5.41	0 0%	—	—
Color of pulp	74	55 74.32	15 20.27	4 5.41	0 0	0 0%	—	—
Size of central column	74	0 0	0 0	55 74.32	19 25.68	0 0%	—	—
Quantity of pith	74	1 1.35	44 59.46	29 39.19	0 0	0 0%	—	—
Quality of pulp	74	21 28.38	37 50.00	12 16.22	4 5.41	0 0%	—	—



smaller disk ring\* is also noticeable. The figure also gives the large percentage of sinuate-based fruits, but the absence of fruits with a naked apex is also very decisive. This character must have given rise to the similar character of the Wase fruits borne on the same tree. The quality of fruit of this lot is not inferior, even under such a heavy infection of sour scab.

The general character of this lot agrees wholly with that of Owari.

### THE BUD VARIATION TREE OF ASAHATA, NEAR SHIDZUOKA

Encouraged by the discovery of the bud variation origin of the Wase Satsuma, the writer organized a large scale search for similar variations in the year 1920. As far as is known, prior to 1918, such examples were represented only by HIGUCHI's case given before and the imperfectly known case from Asahata-mura, Abe-gun, Shidzuoka-ken, already mentioned. With the aid of Mr. Kanesuke HARA of the Shidzuoka Agricultural Society, the writer visited the latter plant on Nov. 26, 1920. The plant in question is located in the orchard of Umekichi HOZAKI, at Koone, Nishiyama, Kita of Asahata village (PL. LI, Fig. 3). It is a medium-sized tree with a 3.5 m. spread in both directions and is 2.6 m. high. The orchard is on an elevated, flat land with a stream, paddy field, and a hill on the north side. The plant is in the second row from the lower part, standing just at the turn of the hill-ridge. The tree is about 32-33 years old, being a plant purchased from a nurseryman called Tsurukichi AOYAMA, and is said to have come from Owari Province. Distances from the surrounding trees vary from 2.6 to 4.4 m. It is a rather dwarf-looking tree with a single upright trunk, 30 cm. in girth at the base. The lower branches are spreading without any connection with the upper part, so that the plant seems to have two stories. The lowermost thick branch of 16 cm. in girth forks immediately after departing from the main trunk. One of these branches runs straight, but the other (13 cm. in girth at the bottom) goes up for

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\* The average diameter of the disk in Wase fruit is 9.04 mm., while that of Owari fruit is only 7.70 mm. Both were measured in 1920.

a while, turns to the left and spreads for a distance of about 1.3 m. The latter is the branch bearing the thoroughly Wase character. The whole tree is covered with leaves but appears ill. The leaves on the Wase branch are more crowded and they are typically lozenge-shaped and twisted, while those on the other part of the tree are normal, large-sized, and somewhat boat-shaped. The owner has known the peculiarity of this branch for the past 20 years, and the fruit is said to mature 20 days earlier than that on the other parts. He once sold the fruits borne on this branch separately from the ordinary crop but no special price was offered for them. The fruit of the whole tree, observed in the field, is extremely round, and is not highly valued in this respect. There are several second generation trees, two of which were bearing this year. The condition of the soil of this orchard seems rather poor, being red silt without pebbles, cover-planted with tea shrub. Fertilizers are only applied to the tea plants (6 *To* per 7 *Se*, or 157 litres per hectare), and generally constitute of fish and bean cakes. The citrus trees are rather neglected.

A second generation tree, propagated by the owner about 10 years ago on trifoliate orange, was also studied at this time. This is a small plant about 1.3 m. high and 1.2 m. in diameter (spread), with a single stem 14.5 cm. in girth, and is divided into three branches at about 10 cm. from the bottom. It is densely foliated and the leaves are much smaller and upright, boat-shaped, and similar in every respect to those on the original branch. The tree is also in a neglected condition, as is the original plant.

Another second generation tree, top-worked on to a Yatsushiro plant with another limb of ordinary Owari Satsuma, is also found in the same orchard (PL. LI, Fig. 4). The plant is located in a pocket-plot of small hill ranges open to the south, where the sun stays on the tree until only about 2 o'clock in the afternoon. It stands on a slope at the western side of a large Satsuma plant and has a girth at the bottom of about 22 cm. above the union. The thicker trunk at 32 cm. from the ground is top-worked with a bud of the original branch, and it has a girth of 14.5 cm. at the union. This branch runs about 15 cm. almost

at the same point, branches into four limbs each one of which measures 1.17, 1.16, 0.88, and 0.69 m., respectively. The leaves on these branches are all crowded and are typical. The interior node is short and the branch is somewhat zigzag at the nodes. It was top-worked by the owner at the same time the other one was grafted. One of the scions top-grafted was taken from an ordinary Satsuma by mistake. The crop was large this year but the size of all the fruits was small and all were almost equal in size.

In visiting the Horticultural Experiment Station at Okitsu, the writer found a top-worked tree of this new Wase Satsuma. Mr. TANIKAWA, of the Station, offered the whole crop of the tree for investigation. This is a small tree about 1.3 m. high, having an E-W spread of 1.45 m. and N-S spread of 1 m. It is located on a hillside experiment plot at about two-thirds way up from the bottom, and is the second tree from the path. The bottom of this plant is a Satsuma with a trifoliate root, planted at a distance of 3.4 m. from the trees on both sides of the same terrace row. The tree has two trunks from the union of the trifoliate stock, both being top-worked with HOZAKI's Wase buds. This is a rather open-headed tree with few branches. The distances between the buds on the branch are rather far, showing a pretty rapid and vigorous growth. The leaves on this plant are exactly similar to those on the original branch in Asahata, but are more or less large in size due to the tree's better condition. The shape of the lamina is lozenge; they are dense, upright, and the affection by sooty mould is pretty severe. The condition of the soil of the orchard is very good, being a reddish loam poor in pebble-content. It is mulched with grasses. It was informed that the plant was propagated by Mr. Yŭzô TAHARA, a student assistant of the station.

31 fruits (Nos. 1556-1586) from the original bud variation limb, named provisionally "Hozaki Wase", were picked on Nov. 28, 1920 and the following note was taken.

Fruits are all tall in shape, ranging from globose to conical, many of them even looking like egg-plants in shape. Surface is smooth, but some of them are rather deeply pitted with dispersed dots (No. 1558).

Size of fruit is large, ranging from large to medium-small. Color is deep, oil cell dots large and dispersed, and in most of the fruits they are convex. Base is mostly lightly depressed and grooved for a short distance in some fruit. Calyx is very characteristic, being very tall, swollen, and the lobes are short, not well developed. The swollen body (tube part) is perfectly smooth without wrinkles, often turning yellow in color. The disk is not enlarged and is concealed under the calyx. Apex is flat and the navel is not prominent. Some fruits are affected by sooty mould.

The cross-section is also very characteristic. The rind is tight, rather thick, oil cells rather crowded, but similar in size to those of the Kawano Wase; inner layer is distinct, white and pithy. Segments are regular, like a sweet orange, and sometimes very few in number; segment wall thick and distinctly white and strong. Each segment has narrow inner end, but the terminal point is rounded. Central column is extremely small, and full of pith. Pulp meaty, containing plenty of juice, and more or less soft. Pulp vesicles are large and their arrangement is just like that of the Kawano Wase, but the vesicle wall is thin, never becoming solid. The quality of the pulp is good, but sometimes becomes insipid by hardening, and changes bitterish in taste as deterioration commences. The last fruit (No. 1586) has a very thin rind, thin segment wall, medium-sized central column, and angular corner to the segments. Its vesiculation is fine, and the juice is deep-colored.

9 fruits (Nos. 1625-1633) from the first second generation tree were also picked on the same day. The following note was taken.

Fruits are large-sized, no medium and small grades; medium in flatness and round-based with large oil cell dots and more or less pitted, deep-colored. General appearance is more like Kawano Wase than the former, but close examination will show that it keeps the characteristics of the original mutant; i.e., (1) depressed stem-end, (2) concealed disk covered by large calyx, (3) swollen calyx tube, very characteristic to this particular type. Tall, pear-shaped fruits are not present in this lot but the largest one (No. 1625) is more or less conical. Sharp, distant

ring around the calyx is often seen. Navel is prominent. Deep-colored, a few with sooty mould infection.

The cross-section is much like the former, i.e., (1) small central column (though not exceedingly small as in the former members), (2) rounded inner end of segment wall, (3) rather thick segment wall, (4) deep-colored pulp, juicy and not hardened, (5) more or less abundant pith at the center, and (6) rather thick rind.

This lot has a very insipid flavor, and the quality is much inferior to the former.

41 fruits (Nos. 1634-1674) from the top-worked 2nd generation tree, also picked on the same day, were recorded as follows:

The general difference between the fruit of this lot and the original is: (1) smaller size of fruit due to over-bearing, (2) almost regularly round fruit (with only one exception, No. 1673, which is tall), (3) thinness and smoothness of the rind, (4) increased flatness of the base of fruit, (5) disk disclosed to some extent, (6) less number of pitted fruits, (7) decreased number of fruits with swollen calyx tube, and occurrence of those with well developed calyx lobes looking like those of Kôji (*Citrus leiocarpa* HORT.), as in fruits Nos. 1559 and 1661, and, (8) absence of depressed stem-end. These characters approach the Kawano Wase, and the cross-section also shows its approach to the general Wase characters, having a thin rind, medium or medium-small central column, medium-much or medium quantity of pith, rounded or angular corner of segments, coarse vesicles, and more or less insipid taste. Some fruits are infected with sooty mould.

48 fruits (Nos. 1751-1798) of the other top-worked plant at Okitsu Horticultural Station were picked on Dec. 4, 1920, and were noted as follows:

Fruits are equally small, globose or tall, smooth-skinned, sooty, with rounded or more or less pointed base and have a less depressed, almost flat area around the calyx. Calyx small, lobes less developed, body (tube part) swollen as in the original lot. Apex flat, not depressed, and with some oil cell dots around the stylar point. Navel less developed.

Cross-section has thin rind, thin segment wall, and almost always

very small central column and small amount of pith. Pulp is juicy, deep-colored, texture soft and fine. Vesicles are still large but their walls are remarkably thin, though the vesiculation is more prominent than in Owari. The corner of the segment is almost angular, and is rounded at the inner end. Flavor pleasantly sweet, less insipid, except in some green ones.

The measurements of these four lots (Nos. 15, 17, 18, and 19 of 1920) are given in Tables 126,\* 127,\*\* 128,\*\*\* and 129.\*\*\*\*

The statistical figures clearly show the tallness of fruit, smallness of the central column, and large quantity of pith. The fruit with the last number is particularly tall.

The fruits of three second generation trees of Hozaki Wase were again sent to the writer for investigation in 1924. (No. 1, lot 128, Nos. 8698-8706; No. 2, lot 129, Nos. 8707-8714; No. 3, lot 130, No. 8715-8733). The examination of these fruits brought the following general remarks.

The fruits are all alike, small, extremely round and tall, possibly partly due to the poor condition of the plants. Surface beautifully smooth and rather well colored (color not bright, probably due to the shaded condition of the tree). Oil cell dots large and flat or convex, not pitted at all. Apex quite rounded, dots usually present around the stylar point. Navel either present or absent. Base quite smooth, rarely double ringed or half double ringed, disk usually not enlarged but in some fruit distinctly enlarged. Calyx distinctly large, lobes being well developed.

The cross-section of the three largest fruits shows a small central column, a small number of irregular segments, thin rind, beautifully colored juicy pulp of medium quality with a mixture of bitterness, very fine vesiculation, more or less thick segment wall and large quantity of pith. The fruit like No. 8708 has exceedingly large pulp vesicles, the

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\* PL. XXV, Fig. 4.

\*\* PL. XXVI, Fig. 1.

\*\*\* PL. XXVI, Fig. 2.

\*\*\*\*PL. XXVI, Fig. 3.

TABLE 126.

MEASUREMENT OF 31 FRUITS (NOS. 1556-1586) OF HOZAKI'S ORIGINAL BUD  
VARIATION BRANCH (HOZAKI WASE) FROM ASAHATA,  
SHIDZUOKA-KEN. LOT NO. 15 OF 1290.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.57 cm.	5.67 cm.	1.21	137.39 gm.	11.51 mm.	9.81	3.00 mm.	11.00 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	31	—	—	—	—	—	13	41.93%
Sinuate based fruits	31	—	—	—	—	—	11	35.48
Semi-sinuate based fruits	31	—	—	—	—	—	5	16.13
Areolated fruits	31	—	—	—	—	—	3	9.68
Frs. with undeveloped calyx lobes	31	—	—	—	—	—	16	51.61
Frs. with long narrow calyx lobes	31	—	—	—	—	—	0	0
Fruits containing seeds	31	—	—	—	—	—	0	0
Apical depression	31	0 0	1 3.23	6 19.35	24 77.42%	—	—	—
Apical dots	31	0 0	6 19.35	25 80.65%	—	—	—	—
Flatness of fruit	31	0 0	0 0	5 16.13	18 58.08	8 25.81%	—	—
Smoothness of fruit	31	6 19.35	19 61.29	5 16.13	1 3.23	0 0%	—	—
Thinness of rind	31	6 19.35	14 45.16	7 22.58	4 12.90	0 0%	—	—
Thinness of segment wall	31	5 16.13	9 29.03	16 51.61	1 3.23	0 0%	—	—
Color of pulp	31	2 6.95	21 67.74	8 25.81	0 0	0 0%	—	—
Size of central column	31	0 0	0 0	2 6.45	7 22.58	22 70.97%	—	—
Quantity of pith	31	8 25.81	17 54.84	6 19.35	0 0	0 0%	—	—
Quality of pulp	31	23 74.19	6 19.35	2 6.45	0 0	0 0%	—	—

TABLE 127.

MEASUREMENT OF 9 FRUITS (NOS. 1625-1633) OF THE FIRST SECOND-  
GENERATION TREE OF HOZAKI'S BUD VARIATION WASE SATSUMA  
(HOZAKI WASE), ASAHATA. LOT NO. 16 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
23.63 cm.	5.84 cm.	1.31	150.11 gm.	11.44 mm.	9.90	3.16 mm.	11.22 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	9	—	—	—	—	—	9	100.00
Sinuate based fruits	9	—	—	—	—	—	6	66.67
Semi-sinuate based fruits	9	—	—	—	—	—	0	0
Areolated fruits	9	—	—	—	—	—	1	11.11
Frs. with undeveloped calyx lobes	9	—	—	—	—	—	2	22.22
Frs. with long narrow calyx lobes	9	—	—	—	—	—	0	0
Fruits containing seeds	9	—	—	—	—	—	0	0
Apical depression	9	0 0	4 44.44	3 33.33	2 22.22%	—	—	—
Apical dots	9	0 0	3 33.33	6 66.67%	—	—	—	—
Flatness of fruit	9	0 0	0 0	4 44.44	5 55.56	0 0%	—	—
Smoothness of fruit	9	1 11.11	6 66.67	2 22.22	0 0	0 0%	—	—
Thinness of rind	9	0 0	7 77.78	2 22.22	0 0	0 0%	—	—
Thinness of segment wall	9	1 11.11	2 22.22	6 66.67	0 0	0 0%	—	—
Color of pulp	9	6 66.67	3 33.33	0 0	0 0	0 0%	—	—
Size of central column	9	0 0	0 0	0 0	3 33.33	6 66.67%	—	—
Quantity of pith	9	0 0	1 11.11	8 88.89	0 0	0 0%	—	—
Quality of pulp	9	2 22.22	3 33.33	4 44.44	0 0	0 0%	—	—



TABLE 128.

MEASUREMENT OF 41 FRUITS (NOS. 1634-1674) OF TOP-WORKED SECOND  
GENERATION TREE OF HOZAKI'S BUD VARIATION WASE SATSUMA  
AT ASAHATA. LOT NO. 17 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.54 cm.	4.66 cm.	1.27	87.09 gm.	9.82 mm.	10.12	2.24 mm.	11.89 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
*Naveled fruits	41	—	—	—	—	—	21	51.22%
Sinuate based fruits	41	—	—	—	—	—	7	17.07
Semi-sinuate based fruits	41	—	—	—	—	—	3	7.32
Areolated fruits	41	—	—	—	—	—	4	9.76
Frs. with undeveloped calyx lobes	39	—	—	—	—	—	16	41.03
Frs. with long narrow calyx lobes	39	—	—	—	—	—	2	5.13
Fruits containing seeds	41	—	—	—	—	—	0	0
Apical depression	41	0 0	1 2.44	10 24.39	30 73.17%	—	—	—
Apical dots	41	4 9.76	18 43.90	19 46.34%	—	—	—	—
Flatness of fruit	41	0 0	4 9.76	25 60.98	11 26.83	1 2.44%	—	—
Smoothness of fruit	41	31 75.61	10 24.39	0 0	0 0	0 0%	—	—
Thinness of rind	41	31 75.61	9 21.95	1 2.44	0 0	0 0%	—	—
Thinness of segment wall	41	18 43.90	21 51.22	2 4.88	0 0	0 0%	—	—
Color of pulp	41	30 73.17	11 26.83	0 0	0 0	0 0%	—	—
Size of central column	41	0 0	3 7.32	18 43.90	14 34.15	6 14.63%	—	—
Quantity of pith	41	0 0	10 24.39	26 63.41	5 12.20	0 0%	—	—
Quality of pulp	41	10 24.39	18 43.90	13 31.71	0 0	0 0%	—	—

**TABLE 129.**  
**MEASUREMENT OF 48 FRUITS (NOS. 1751-1798) OF TOP-WORKED SECOND**  
**GENERATION TREE OF HOZAKI'S BUD VARIATION WASE SATSUMA**  
**AT OKITSU STATION. LOT NO. 18 OF 1920.**

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.90 cm.	4.51 cm.	1.19	70.44 gm.	9.59 mm.	9.48	2.21 mm.	7.96 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	48	—	—	—	—	—	10	% 20.83
Sinuate based fruits	48	—	—	—	—	—	6	12.50
Semi-sinuate based fruits	48	—	—	—	—	—	1	2.08
Areolated fruits	48	—	—	—	—	—	11	22.92
Frs. with undeveloped calyx lobes	48	—	—	—	—	—	33	68.75
Frs. with long narrow calyx lobes	48	—	—	—	—	—	0	0
Fruits containing seeds	48	—	—	—	—	—	0	0
Apical depression	48	0 0	1 2.08	22 45.83	25 52.09%	—	—	—
Apical dots	48	3 6.25	13 27.08	32 66.66%	—	—	—	—
Flatness of fruit	48	0 0	0 0	14 29.17	20 41.67	14 29.17%	—	—
Smoothness of fruit	48	28 58.33	20 41.67	0 0	0 0	0 0%	—	—
Thinness of rind	48	41 85.42	7 14.58	0 0	0 0	0 0%	—	—
Thinness of segment wall	48	40 83.33	7 14.58	1 2.08	0 0	0 0%	—	—
Color of pulp	48	26 54.17	18 37.50	3 6.25	0 0	1 2.08%	—	—
Size of central column	48	0 0	0 0	2 4.17	6 12.50	40 83.33%	—	—
Quantity of pith	48	0 0	7 14.58	17 35.42	15 31.25	9 18.75%	—	—
Quality of pulp	48	22 45.83	13 27.08	13 27.08	0 0	0 0%	—	—

TABLE 130.

MEASUREMENT OF 36 FRUITS (NOS. 8698-8733) FROM THREE SECOND GENERATION TREES OF HOZAKI WASE AT ASAHATA, SHIDZUOKA-KEN, COUNTED TOGETHER. LOT NOS. 128, 129, 130 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.98 cm.	4.58 cm.	1.25	81.53 gm.	11.06 mm.	9.72	2.13 mm.	9.74 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	36	—	—	—	—	—	17	47.22%
Sinuate based fruits	36	—	—	—	—	—	4	11.11
Semi-sinuate based fruits	36	—	—	—	—	—	0	0
Areolated fruits	36	—	—	—	—	—	8	22.22
Frs. with undeveloped calyx lobes	36	—	—	—	—	—	2	5.56
Frs. with long narrow calyx lobes	36	—	—	—	—	—	0	0
Fruits containing seeds	36	—	—	—	—	—	0	0
Apical depression	36	0 0	0 0	14 38.89	22 61.11%	—	—	—
Apical dots	36	6 17.14	20 57.14	9 25.71%	—	—	—	—
Flatness of fruit	36	1 2.78	3 8.33	12 33.33	15 41.67	5 13.89%	—	—
Smoothness of fruit	36	35 97.22	1 2.78	0 0	0 0	0 0%	—	—
Thinness of rind	36	22 61.11	12 33.33	2 5.56	0 0	0 0%	—	—
Thinness of segment wall	36	1 2.78	9 25.00	21 58.33	5 13.89	0 0%	—	—
Color of pulp	36	6 16.67	15 41.67	13 36.11	2 5.56	0 0%	—	—
Size of central column	36	0 0	4 11.11	16 44.44	14 38.89	2 5.56%	—	—
Quantity of pith	36	6 16.67	25 69.44	5 13.89	0 0	0 0%	—	—
Quality of pulp	36	0 0	8 22.22	18 50.00	10 27.78	0 0%	—	—

demarcation of which is not clear due to the thinness of their walls. The cross-sections of the rest look all alike. Rind usually thin, but each fruit has a non-uniform thickness of rind, varying from very thin to medium. This unequal growth of rind is probably due to the poor or sick condition of the tree. Central column varying from medium-large to small, average larger than medium, with abundant pith which is solid and splits into parts. Corner of segments rounded, carpel rather adherent, rind brittle, whitish, oil cells sparse and distinct. Number of segments is decidedly few. Pulp rather hard, meaty; vesiculation coarse and not whitened nor roughened. Color of pulp rather light, average is medium, rarely deep. Taste usually insipid, lacking both acid and sugar. Some are conspicuously bitter. Flavor at any rate inferior. The crop seems to be abnormal, although the fruit looks good from the outside, but was grown apparently under conditions of neglect.

The measurements of fruits are given in Table 130\*.

### INVESTIGATION OF FRUITS OF THE NORMAL PART OF HOZAKI'S BUD VARIATION TREE AT ASAHATA

It is worthy of note that the tallness of the fruits of the Hozaki Wase (HOZAKI'S bud variation Wase Satsuma) comes from the original plant as one of the characteristics of that individual and this can be verified through the study of the normal fruits of that tree.

Total crop of 38 fruits (Nos. 1587-1624) from the normal part of the original bud variation plant found in HOZAKI'S orchard were picked on Nov. 28, 1920, and studied at Shidzuoka. The following note was taken from this lot (No. 16 of 1920).

Fruits are medium-sized, varying from medium to small, globose, compact, and minutely pitted or becoming smoother, shape being more or less conical. Base is sinuate, and no distinct groove develops, sometimes a wart-like protrusion is present on one side of the calyx. Calyx large or small, lobes developed or undeveloped, some are swollen. Navel

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\* PL. XXVI, Fig. 4, & PL. XXVII, Fig. 1.

stylar point. Navel very well developed. Fruit base is flattened but is rather shallowly depressed and grooved due to over-maturity, though never strongly concave as in Owari fruits. These grooves are few in number, large, shallow, and long. Depression of the apex is broad and more or less deep, areolated, but the ring is not strongly pitted. Calyx is large, the body (tube part) especially large and the disk is also large.

Halved fruits have mostly a thin rind, are puffy due to being over-ripe, and often have a wide space between the rind and the pulp ball. Oil cells are large and are usually arranged in one row. Inner layer is raggy in the much puffed fruits with a more or less large amount of pith, but it is only fibrous in thin-skinned fruits. Segment wall is very thin in many cases and is readily separable. The inner end of the segment is simply blunt-tipped, but is acutely pointed in smaller fruits. Pulp is generally abundant, medium-deep-colored (bleached after full maturity), becoming very insipid, although still juicy and soft. Pulp vesicles large, thin-walled, wall being hardly visible. Seeds are very rarely present. Often attacked by *Penicillium* mould, when decay follows very quickly, causing a subsequent change of flavor.

The fruit is very attractive owing to its large size and medium flat outline. Even the smallest members rank in the large group of average Satsuma fruits.

The first lot of 136 fruits (Nos. 4724-4859) of the second generation tree No. 1 is also similar to the former lot, only differing in the following points: (1) fruits are extra large, much larger than the former lot; (2) condition is more sound, not many being split; (3) among the larger ones, tall, compact, and pitted ones are more in number than in the former; (4) color of rind is deeper than in the above; (5) fruits with thicker rind are more plentiful; (6) color of pulp is much deeper; and (7) insipidness of the pulp is very much less in extent.

TABLE 132.

MEASUREMENT OF 136 FRUITS (NOS. 4724-4856) OF NO. 1 SECOND GENERATION  
TREE OF SHINTANI'S BUD VARIATION WASE SATSUMA (SHINTANI  
WASE). LOT NO. 7 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts	Rind	Center
24.08 cm.	5.41 cm.	1.41	147.67gm.	9.05 mm.	11.01	3.20 mm.	15.80 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	135	—	—	—	—	—	93	% 68.89
Sinuate based fruits	136	—	—	—	—	—	2	1.47
Semi-sinuate based fruits	136	—	—	—	—	—	1	0.74
Areolated fruits	136	—	—	—	—	—	104	76.47
Frs. with undeveloped calyx lobes	134	—	—	—	—	—	53	39.55
Frs. with long narrow calyx lobes	134	—	—	—	—	—	14	10.45
Fruits containing seeds	136	—	—	—	—	—	1	0.74
Apical depression	135	49 36.30	69 51.11	16 11.85	1 0.74%	—	—	—
Apical dots	136	44 32.35	31 22.79	61 44.85%	—	—	—	—
Flatness of fuit	136	19 13.97	70 51.47	33 24.26	12 8.82	2 1.47%	—	—
Smoothness of fruit	136	18 13.24	63 46.32	44 32.35	8 5.88	3 2.21%	—	—
Thinness of rind	136	104 76.47	22 16.18	7 5.15	2 1.47	1 0.74%	—	—
Thinness of segment wall	136	85 62.50	34 25.00	16 11.76	1 0.74	0 0%	—	—
Color of pulp	136	58 42.65	71 52.21	7 5.15	0 0	0 0%	—	—
Size of central column	136	1 0.74	3 2.21	75 55.15	47 34.56	10 7.35%	—	—
Quantity of pith	136	0 0	28 20.59	102 75.00	5 3.68	1 0.74%	—	—
Quality of pulp	133	15 11.28	57 42.96	58 43.61	3 2.26	0 0%	—	—

TABLE 133.

MEASUREMENT OF 178 FRUITS (NOS. 4531-4708) OF NO. 2 SECOND GENERATION  
TREE OF SHINTANI'S BUD VARIATION WASE SATSUMA (SHINTANI  
WASE) AT HISATOMO. LOT NO. 8 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts	Rind	Center
22.33 cm.	4.79 cm.	1.49	100.44gm.	10.66 mm.	10.74	3.10 mm.	15.56 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	178	—	—	—	—	—	106	59.55%
Sinuate based fruits	178	—	—	—	—	—	1	0.56
Semi-sinuate based fruits	178	—	—	—	—	—	2	1.12
Areolated fruits	178	—	—	—	—	—	101	56.74
Frs. with undeveloped calyx lobes	176	—	—	—	—	—	97	55.11
Frs. with long narrow calyx lobes	176	—	—	—	—	—	8	4.55
Fruit containing seeds	178	—	—	—	—	—	1	0.56
Apical depression	178	40 22.47	96 53.93	42 23.60	0 0%	—	—	—
Apical dots	178	97 54.49	49 27.53	32 17.98%	—	—	—	—
Flatness of fruit	178	17 9.55	115 64.61	43 24.16	2 1.12	1 0.56%	—	—
Smoothness of fruit	178	98 55.05	73 41.01	5 2.81	2 1.12	0 0%	—	—
Thinness of rind	178	145 81.46	23 12.92	9 5.06	1 0.56	0 0%	—	—
Thinness of segment wall	178	161 90.45	14 7.87	3 1.69	0 0	0 0%	—	—
Color of pulp	178	18 10.11	94 52.81	66 37.08	0 0	0 0%	—	—
Size of central column	178	1 0.56	15 8.43	131 73.60	24 13.48	7 3.93%	—	—
Quantity of pith	178	0 0	26 14.61	134 75.28	17 9.55	1 0.56%	—	—
Quality of pulp	177	1 0.56	33 18.64	142 80.22	1 0.56	0 0%	—	—

The measurements of these two lots of fruit are given in Tables 132\* and 133.\*\*

The second lot with larger fruit has more flat fruits than the other and is rather extensively thin-rinded and thin-walled. In all other respects, they are quite similar, but the quality of fruit did not mean much at the time when the observation was made.

### INVESTIGATION OF THE OWARI FRUITS OF SHINTANI'S BUD VARIATION TREE

Thirteen fruits were picked from the normal part of SHINTANI's bud variation tree (Shintani Wase) in 1920 and were investigated thoroughly.

The fruits are rather tall, medium to medium-large in size. Surface even, and oil cell dots are all pitted, often very sharply. Equatorial outline is very regular. Basal grooves are not very pronounced. Calyx rather large, mostly pressed in forming a sinuous stem-end. Rind texture very near to the Wase, having dispersed oil cell dots. Apex more or less depressed, often strongly areolate. Color rather light, appearance rather puffy. Navel not generally developed.

The cross-section of the fruit is a typical Owari, having thin rind, and medium to medium-small central column, conspicuously larger than in the Wase fruits. Pulp deep-colored, juicy, fine grained, but rather poor in taste. Outer end of segment is parallel to the rind surface, and the inner end is triangular, the side thicker than in the Wase. Seedless.

The measurements of fruits are given in Table 135.\*\*\*

These fruits are smaller than those of the Wase borne on the same tree and the characteristic of the base, with a smaller calyx and disk, is very different. These fruits are also more pitted, have a thicker skin, and are apparently deep-colored and the pulp is not discolored as in the case when the Wase fruits are over-ripe.

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\* PL. XXVII, Fig. 3.

\*\* PL. XXVIII, Fig. 1.

\*\*\*PL. XXVIII, Fig. 2.



TABLE 135.

MEASUREMENT OF 13 FRUITS (NOS. 4709-4721) OF NORMAL PART OF  
SHINTANI'S BUD VARIATION TREE (OWARI SATSUMA) AT  
HISATOMO, HIROSHIMA-KEN. LOT NO. 6 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.00 cm.	4.84 cm.	1.88	10.82 gm.	9.42 mm.	10.22	3.13 mm.	12.62 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	13	—	—	—	—	—	2	15.38
Sinuate based fruits	13	—	—	—	—	—	5	38.46
Semi-sinuate based fruits	13	—	—	—	—	—	6	46.15
Areolated fruits	13	—	—	—	—	—	9	69.23
Frs. with undeveloped calyx lobes	13	—	—	—	—	—	7	53.85
Frs. with long narrow calyx lobes	13	—	—	—	—	—	0	0
Fruits containing seeds	13	—	—	—	—	—	0	0
Apical depression	13	2 15.38	8 46.54	3 23.08	0 0%	—	—	—
Apical dots	13	5 38.46	6 46.15	2 15.38%	—	—	—	—
Flatness of fruit	13	0 0	6 46.15	5 38.46	2 15.38	0 0%	—	—
Smoothness of fruit	13	0 0	0 0	8 61.54	5 38.46	0 0%	—	—
Thinness of rind	13	9 69.23	3 23.08	1 7.69	0 0	0 0%	—	—
Thinness of segment wall	13	4 23.27	8 46.54	1 7.69	0 0	0 0%	—	—
Color of pulp	12	9 75.00	3 25.00	0 0	0 0	0 0%	—	—
Size of central column	12	0 0	0 0	7 58.33	4 33.33	1 8.33%	—	—
Quantity of pith	12	0 0	0 0	12 100.00	0 0	0 0%	—	—
Quality of pulp	8	0 0	0 0	8 100.00	0 0	0 0%	—	—

Table No. 134 does not exist.

### SUEOKA'S WASE SATSUMA AT ÔCHÔ

In the midst of the center of commercial Kawano Wase cultivation in Japan a striking Wase Satsuma of entirely different origin was discovered in 1920, in an orchard belonging to Mr. Gosaku SUEOKA, one of the most active Kawano Wase planters at Ôchô. His orchard is located at Hisashi, Nishiminami, Ôchô-mura, Toyota-gun, Hiroshima-ken, and there is a large Kunembo tree on a hillside facing the south, standing as the third tree in the eighth row from the south. This plant is top-worked partly with Satsuma buds, and partly with Washington Navel buds (PL. LI, Fig. 6, 6", and 6"). The Satsuma branches on this tree were propagated from one of the two huge old Satsuma trees which was blown down about 1909, 7 or 8 years after the other had fallen. Both were grafted plants and were Owari of unknown origin. The fruit of these particular trees attracted much attention from Mr. SUEOKA when he was a boy of about six or seven years. He does not remember whether these favorite fruits of his came from any part of the tree or from a certain limited branch. He asked his father, Mr. Yasumatsu SUEOKA, now 74 years old, to propagate the ones yielding such extremely sweet fruits, and this desire was fulfilled in 1908, just one year before the last plant was gone. The present top-worked Satsuma originated this way, and thus retained its speciality, this desirable quality. Fruits from this top-worked Satsuma were first exhibited at an agricultural fair at Hiroshima held in 1912 and won first prize. On the day the decision was reached, the judge, Prof. ONDA of the Imperial Horticultural Experiment Station, told Mr. SUEOKA that his "Wase Satsuma" had won the highest prize. SUEOKA, however, declined to use the name "Wase Satsuma" for his exhibits because he believed that only Kawano Wase from Aoe deserves this name, and his was "Kanro Unshû" of an entirely different origin, as provisionally named by him. Being convinced by Prof. ONDA, he had to change his view, and realized that his favorite comes under the category of the Wase Satsuma even if its origin is different. This brought him discouragement rather than encouragement and he began to mix the fruit from the top-worked tree with the ordinary Kawano Wase produced abundantly in his orchard. He began to neglect this particular plant and did not recollect its value

until the author found its merit as an independent strain of Wase Satsuma, and separately named it "Sueoka Wase". On October 5, 1920 the author was able to study the top-worked tree very thoroughly, with the aid of Mr. SUEOKA, and it was concluded that this is an entirely new strain of Wase Satsuma. The detailed description of the plant is as follows:

The plant is on a cliff, at a distance of 6.1 m. from the southern tree and has a spread in the E-W direction of 6.3 m., N-S direction of 5.5 m., and a height of 3.5 m. The Satsuma branches in general look elongated and drooping, with dense foliage, and some of the branches are considerably twisted, especially the younger ones. By observing closely, two kinds of branches are found within the Satsuma top, as stated below:

**No. 1\*.** On the western branch, grafted at 63 cm. from the main trunk, two limbs arise from the same place, possibly coming from two independent buds, both being Wase. Girth of the original branch is 26 cm. that of the grafted branches 15 cm. and 13 cm. in girth, respectively. Nos. 4 and 10 have a common lower end with this, constituting one of the largest main branches arising near the root of the plant.

**Nos. 2 and 3.** On the high branch arising from the main trunk. No. 2 is an Owari about 2 m. long, very upright and straight, not drooping, with rather dispersed leaves, large and narrow. No. 3 is a Wase, drooping considerably as compared with the former.

**No. 4.** On the northern side and upon the same limb as the No. 1 branch. It is a large branch of Wase.

**Nos. 5 and 6.** On the large main branch of the stock arising from the trunk at the northern side of the former branch which bears limbs Nos. 1, 4, and 10. This main branch has two limbs, and the northern one forks again into two, bearing shoots Nos. 5 and 6 at each top. No. 5 is an Owari and No. 6 a Wase. The former was top-worked in 1917, and buds were apparently taken from the other Owari limb found on the same tree.

**Nos. 7 and 9.** On one of the head branches of the upper part of the trunk on the southern side, bearing two grafts of Wase, apparently also top-worked in 1917.

**No. 8.** On the eastern branch arising from the lower part of the trunk, having one limb top-worked with Washington Navel and the other limb with Satsuma orange; the latter was found to be a Wase, here numbered.

**No. 10.** On the lower limb of the branch which bears limb No. 1 mentioned before, top-worked in 1917. This is Owari, taken from the same tree.

**No. 11, 12, and 13.** On a large limb arising from the upper part of the trunk, first two being Owari and the last being Wase.

\* Numbers are given to each of the Satsuma branches without order.

**Nos. 14, 15, and 16.** Ont he western branch of the northern limb, which bears Nos. 5 and 6 on the eastern side. Nos. 14 and 15 are Owari and 16 is Wase.

**No. 17.** On the middle part of the main trunk; it is Wase.

Branches Nos. 8, 10-17 were top-worked in 1917, and only the four lower numbers constitute the original top-work done in 1908. These are, therefore, the five buds from the original tree which died in 1909 (No. 1 bears two buds), and except No. 2, they are all Wase, the socalled "Kanro Unshû" of Mr. SUEOKA. If the Owari (No. 2) came from the same old plant, the original tree must have been either a bud variation tree or a grafted Wase bearing a reverting shoot. According to the interpretation of Mr. SUEOKA, both of the huge old plants were the same, so that it seems that each tree was a Wase propagated unintentionally from a certain bud variation tree which existed even earlier. Branch No. 2 if it was not cut from an entirely different tree by mistake, seems to represent a reverting shoot of the original tree, but of course this can never be confirmed. The original trees were planted by Sakubei SUEOKA great-grandfather of Mr. Gosaku SUEOKA. His grandfather, Chôzaburô, was adopted from the ISHIDA family and died in 1899, at the age of 76. This man's real father, Isaburô ISHIDA, propagated many trees and some of them were 69 years old in 1920. Mr. Gosaku SUEOKA remembers very well that the original old tree of the present Wase Satsuma was undoubtedly older than this 69 year old tree, so that he estimates that it would be at least 80 years old in 1920, or still older. If the two old trees were thoroughly Wase and if they came from an other Wase branch which had existed before, the original bud variation must have occurred at least 100 years before 1920. This reference will show how early such a Wase mutation may have existed in Japan.

The investigation on fruit was carried out for the first time in 1920 (Lot Nos. 9 and 10 of 1920).

The Wase fruits, 166 altogether, were sent and they were all Wase in general character but were strictly different from Kawano Wase. (Comparison was made with MAMYÔ's Kawano Wase fruits from the same village, given in Table 113). The difference of SUEOKA's fruits from the others, is (1) they are flatter in a great majority, (2) the transverse outline is undulate, especially in larger fruits, (3) they are deeply depressed and grooved at the base, (4) they have well developed calyx lobes, (5) uniformly thin rind, thin segment wall and deep-colored pulp, and (6) smaller, pithless central column.

The fruits are large, ranging from extra large to medium, keeping wonderfully their smoothness when the size increases. Shape is flat, ranging from very flat to medium, and the stem end is rather deeply concave. The large-sized ones are somewhat soft and wavy, but are not exactly baggy, while the medium-sized ones are all tight-skinned. Calyxes are extremely large and the lot contains many individual fruits with long narrow lobed ones. The depression of the calyx and resembles somewhat the Owari in giving a rather deep concavity and radiating furrows, but the rectangular shape and extremely polished smooth skin is impossible in an Owari. The development of furrows in Wase fruits is rather unusual, but these furrows are mostly shallow and short, never so marked as in Owari fruits, and unquestionably the development of such grooves is due to the extra large size and to over-maturity. The apex of the fruit is also depressed, with prominent navel and distinct areola. A few fruits are infected with sooty mould or melanose fungus.

The cross-section of the fruit shows amazingly good characters. The rind is uniformly thin, even in extra large fruits. Segment wall also thin, and central column small in size, with very small amount of pith. Pulp is considerably large in amount, very juicy, fine grained, and very palatable. Its superior quality perhaps makes this the highest in rank of all varieties and strains known up to that time, and probably it still keeps its position among the best types of all Satsumas. Some medium-good and medium-flavored fruits are evidently those which are over-ripe and which changed flavor during transit and storage. Notwithstanding that the extra large size and the smoothness of the fruit is more attractive than in any other varieties of Satsuma, the fruit has the defect of an extremely perishable nature, as the lot came with many split fruits.

The measurements of the fruits are given in Table 136.\*

In 1924 another investigation on fruit was made and it was verified that the Sueoka Wase is still a very excellent strain. Notes taken this year as follows:

The fruit is uniformly flat and looks very beautiful and desirable,

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\* PL. XXVIII, Fig. 3.

TABLE 136.

MEASUREMENT OF 166 FRUITS (NOS. 1179-1337, 1355-1361) OF SUEOKA'S WASE  
SATSUMA (SUEOKA WASE) FROM ÔCHÔ-MURA, TOYOTA-GUN,  
HIROSHIMA-KEN. LOT NO. 9 AND 10 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.73 cm.	4.69 cm	1.47	123.38gm.	8.18 mm.	11.27	2.14 mm.	14.56 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	166	—	—	—	—	—	106	% 63.86
Sinuate based fruits	166	—	—	—	—	—	10	6.02
Semi-sinuate based fruits	166	—	—	—	—	—	7	4.22
Areolated fruits	166	—	—	—	—	—	115	69.27
Frs. with undeveloped calyx lobes	162	—	—	—	—	—	32	19.75
Frs. with long narrow calyx lobes	162	—	—	—	—	—	24	14.82
Fruits containing seeds	163	—	—	—	—	—	2	1.23
Apical depression	166	51 30.72	81 48.80	34 20.48	0 0%	—	—	—
Apical dots	166	18 10.84	89 53.61	59 35.54%	—	—	—	—
Flatness of fruit	166	107 64.46	42 25.30	16 9.64	1 0.60	0 0%	—	—
Smoothness of fruit	166	73 46.99	82 49.40	6 3.61	0 0	0 0%	—	—
Thinness of rind	163	159 97.55	4 2.45	0 0	0 0	0 0%	—	—
Thinness of segment wall	163	135 82.82	24 14.72	4 2.45	0 0	0 0%	—	—
Color of pulp	163	130 79.75	31 19.02	2 1.22	0 0	0 0%	—	—
Size of central column	163	0 0	8 4.91	72 44.17	61 37.42	22 13.50%	—	—
Quantity of pith	163	0 0	4 2.45	81 49.69	52 31.90	26 15.95%	—	—
Quality of pulp	163	76 46.63	58 35.58	23 17.18	1 0.61	0 0%	—	—

being bright-colored, smooth, and having large flat oil cell dots. Size large (not extremely large this year), apex gradually shallow and broadly concave, with rather well marked areola. Navel is present but not extremely prominent, and oil cell dots are lacking around the styler point in many fruits. Oil cell dots on the surface of the fruit are large dispersed, convex, or rarely pitted. Base not so much concave as in the other year, being broad-concave at the least, very seldom sinuate at the stem-end, and only exceptionally furrowed. Fine radial striations around the calyx are not distinct in some fruit. Disk ring is large, but is not conspicuously broad as in Kawano Wase, although it is not at all like that of the Owari fruits. Calyx is not very large but lobes are well developed and frequently elongated narrow ones are formed. The fruit is considerably heavy and is subject to break age by a light pressure so that many of them came with split apices.

In cross-section all fruits, from large to small, are homogeneously thin-skinned, containing a very large amount of pulp which is extremely juicy, soft, and good flavored. Segment wall thin, central column small, and pith little in amount. These accounts agree with all that was found in the previous year. Closer study shows that the oil cells are medium-large, usually standing close together and being rounded. The rind, even in the largest, does not exceed 4 mm. in thickness at the thickest portion. Segment wall is tenacious, easily broken, but still easily separable. Central column is medium to medium-small, noticeably keeping a very small quantity of pith. Pulp juicy, not meaty; vesiculation almost invisible, the vesicular wall being very thin. The netting of the pulp is fine, not coarse as in the average Kawano Wase, most deeply colored, extremely and equally good in quality. The flavor is exactly like honey and in slightly over-ripe fruit or in a split one, it tends to begin to deteriorate. This is perhaps the Wase Satsuma best fitted to small home plantings.

Many fruits were stored until the end of February without much deterioration, so that its keeping quality is not so inferior as one might expect.

TABLE 137.

MEASUREMENT OF 59 FRUITS (NOS. 9223-9281) OF SUEOKA'S WASE SATSUMA  
(SUEOKA WASE) FROM ÔCHÔ. LOT NO. 147 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.99 cm	4.33 cm.	1.54	108.98 gm.	11.33 mm.	10.83	2.35 mm.	15.19 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	59	—	—	—	—	—	21	% 25.59
Sinuate based fruits	59	—	—	—	—	—	2	3.39
Semi-sinuate based fruits	59	—	—	—	—	—	0	0
Areolated fruits	59	—	—	—	—	—	52	88.14
Frs. with undeveloped calyx lobes	58	—	—	—	—	—	3	5.17
Frs. with long narrow calyx lobes	58	—	—	—	—	—	22	37.93
Fruits containing seeds	59	—	—	—	—	—	0	0
Apical depression	59	2 3.39	34 57.63	22 37.29	1 1.69%	—	—	—
Apical dots	59	22 37.29	35 59.32	2 3.39%	—	—	—	—
Flatness of fruit	59	45 76.26	12 20.34	2 3.39	0 0	0 0%	—	—
Smoothness of fruit	59	30 50.85	24 40.68	5 8.47	0 0	0 0%	—	—
Thinness of rind	59	53 89.83	6 10.17	0 0	0 0	0 0%	—	—
Thinness of segment wall	59	55 93.22	4 6.78	0 0	0 0	0 0%	—	—
Color of pulp	59	59 100.09	0 0	0 0	0 0	0 0%	—	—
Size of central column	59	1 1.69	12 20.34	44 74.58	2 3.39	0 0%	—	—
Quantity of pith	59	0 0	2 3.39	10 16.95	47 79.66	0 0%	—	—
Quality of pulp	56	43 72.88	13 22.03	0 0	0 0	0 0%	—	—



The measurements of fruits are given in Table 137.\*

In both lots, flatness of fruits and smoothness of the surface are well marked. Thinness of the rind and segment wall is also well characterized, but the central column is larger in the second lot. The naked region around the styler point is much less in the former, and even not prominent in the latter, and this seems to be a character of this Wase which is different from the Kawano Wase. The less developed navel and basal grooves in the latter lot are undoubtedly due to temporary variation, but a character like the development of long narrow lobes of the calyxes seems constant in both years. Comparatively large-sized central column is mainly due to the long storage of the fruit for the test.

### OWARI FRUITS OF THE SUEOKA WASE TREE

The fruit borne on the original top-worked Sueoka Wase tree was first studied Feb. 3-7, 1925. The following note was taken during the investigation.

Fruits large to small, average medium, rather rough skinned, pitted much and grooved at the stem-end. Horizontal outline is rather irregular. Surface bright-colored and oily. Calyx large with well developed lobes, rarely developing long narrow ones. Disk generally hidden under the calyx without extension of the margin. Basal grooves prominent, and in no case the stem-end is flattened as in the Wase; deeply depressed and sometimes sinuate. Pitting of oil cell dots is strong; puffy, undulate, and light in weight. Apex with strong areola, and the great majority of them are roughly double-ringed. The areola enclosed area is very concave and often this depressed area is sharply marked at the inner edge of the areola. Navels are developed but are not prominent. Rind hard but puffy. No blemishes, except that a certain fruit had moulded.

The cross-section shows a thick rind coming loose from the pulp ball, being puffy. Central column ranging from large to small, but generally larger than medium and pith is more than medium grade, sometimes hard, with two or three carpel ends fastened together, but generally soft

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\* PL. XXIX, Fig. 1.

TABLE 138.

MEASUREMENT OF 62 FRUITS (NOS. 9232-9343) OF OWARI BRANCH FROM  
SUEOKA'S TOP-WORKED TREE HAVING SUEOKA WASE BRANCHES,  
AT ÔCHÔ. LOT NO. 148 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.94 cm.	4.31 cm.	1.39	92.68 gm.	10.04 mm.	10.84	2.85 mm.	13.82 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	62	—	—	—	—	—	16	% 25.81
Sinuate based fruits	62	—	—	—	—	—	3	4.84
Semi-sinuate based fruits	62	—	—	—	—	—	5	8.06
Areolated fruits	62	—	—	—	—	—	61	98.39
Frs. with undeveloped calyx lobes	62	—	—	—	—	—	6	9.68
Frs. with long narrow calyx lobes	62	—	—	—	—	—	1	1.61
Fruits containing seeds	62	—	—	—	—	—	0	0
Apical depression	62	54 87.10	5 8.06	3 4.84	0 0%	—	—	—
Apical dots	62	2 3.23	40 64.52	20 32.26%	—	—	—	—
Flatness of fruit	62	25 40.32	23 37.10	13 20.97	1 1.61	0 0%	—	—
Smoothness of fruit	62	0 0	11 17.74	27 43.55	24 38.71	0 0%	—	—
Thinness of rind	62	4 6.45	22 35.48	31 50.00	5 8.06	0 0%	—	—
Thinness of segment wall	62	18 29.03	35 56.45	9 14.52	0 0	0 0%	—	—
Color of pulp	62	22 35.48	20 32.26	18 29.03	2 3.23	0 0%	—	—
Size of central column	62	5 8.06	24 38.71	25 40.32	5 8.06	3 4.84%	—	—
Quantity of pith	62	1 1.61	21 33.87	39 62.90	1 1.61	0 0%	—	—
Quality of pulp	56	13 23.21	21 37.50	19 33.93	0 0	3 5.36%	—	—

and cottony. Pulp comparatively lighter in color, but occasionally rather deep; juicy and generally fair in quality, including a few sour fruits due to their over-ripe condition; vesiculation indistinct, fine grained, and melting. Seeds not found. The flavor of fruit is not good being rather inferior and not desirable for the late fruit market.

The measurements of the fruits are given in Table 138.\*

This table shows that a great difference exists when compared to the fruit of the Wase branches, and that it rather closely resembles the figures obtained from the reverted fruits of the Kawano Wase given in Tables 115 and 117. The Wase fruits, in comparison with this lot, have a thinner and more brittle rind and a juicier pulp. It is remarkable that this lot contains only just a few fruits with naked apices and calyxes with elongated lobes.

### THE ISHIKAWA WASE FROM SHIDZUOKA PREFECTURE

In 1920, Mr. Kanesuke HARA made a provisional survey of the Satsuma orange in Shidzuoka Prefecture to detect anything unusual from the normal, and a request of the writer brought to light several interesting cases of Wase bud variation, including this new strain. On November 26, 1920, the plant belonging to Mr. Kumaji ISHIKAWA was visited at Hofukushima, Toyoda-mura, Shida-gun, Shidzuoka-ken. The plant stands by a small pond in the owner's small Japanese garden near the house (PL. LI, Fig. 7). This single plant came from an unknown locality and was planted with others in the orchard, about 25 years before 1920. It is a tree about 3.5 m. in spread and 2.6 m. in height, being a typical Owari tree with straight, somewhat boat-shaped, rather crowded leaves and large, flat, smooth fruits. The main trunk is very short, being 4.6 cm. in girth. It divides into two secondary trunks at about 15 cm. from the ground, and the northern trunk has a straight, almost horizontal, limb at a point 52 cm. from the bottom. The bud variation Wase branch arises on this limb at 58 cm. from its bottom, and is quite upright, branching again, one part reaching a length of

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\* PL. XXIX, Fig. 2.

1.08 m. from the bottom, and the other 93 cm. The leaves on the Wase part look quite similar to those of the Kawano Wase, being considerably light-colored, much crowded, short and broad, more or less boat-shaped, and nearly all straight upright. This branch bears a number of beautiful fruits, which look like typical Wase in smoothness and in the large convex oil cell dots.

The garden soil is loam with a quantity of gravel and is covered with river pebbles. No fertilizer is applied and the plant is slightly unhealthy due to the attack of a saline wind in 1918. The bud variation was discovered by the owner about 1915. The coloring of the fruit starts about the middle of October, that is about one month in advance of the common Satsuma orange. No commercial shipment of the fruit was tried and no successful propagation was ever made.

The crop of the whole tree was examined in 1920. 28 Wase fruits (Nos. 1362-1389) are all remarkably large-sized, and no medium or small grade fruits were in the lot. The outline of fruit is depressed globose, resembling Kawano Wase, and is somewhat conical. The surface is smooth with very large-sized oil cell dots, even or convex. The stem-end is slightly depressed with large calyx and distinct flat disk. Calyx lobes are more or less thick and well developed. Apex broadly shallow depressed, without areola, and the naked area around the styler point is lacking. Navels are well developed. All are tight-skinned and fully mature when picked on Nov. 26, 1920. Blemishes are none, but thrips scratches from thrips are many.

The cross-section of the fruit shows that the rind is very thin, segment wall also thin, central column small, pulp much in quantity, vesicles large and distinct, juicy but somewhat dry and discolored, the fruit having been kept too long on the tree. The flavor is quite insipid and entirely lacks acidity; unquestionably due to over-maturity of the fruit. Pith in the central column in larger fruits is abundant, but is not hard, more like snow-flakes (floccose). In some fruit, the segment wall is thicker but is not white and is easily broken. Segments in some fruit are extremely large and in such segments vesiculation is very anastomose. Outer corner of the segment is rounded even in thin-skin-

ned fruit, inner end being also rounded. Oil cells of the rind are globose, regularly in one row, arranged rather far apart from one another.

The measurements of fruits are given in Table 139.\*

The crop of the same tree was re-examined in November, 1924, and the following note was taken for the Wase fruits (Nos. 8591-8621).

The size of the fruit is gigantic, appearing quite attractive. The shape is rather tall, but some are quite flat. The horizontal outline is somewhat irregular due to the existence of the abnormally large-sized segments. The surface is beautifully orange-colored, still containing a few greenish patches; oil cell dots very pronounced, no fovea, looking rough by their convexity but some fruits are quite polished. Apex usually not much depressed, areolated, often with naked area around the stylar point. Navel very prominent. The stem-end resembles Kawano Wase, often with a double ring around the calyx, and about one-third of the total fruits have an enlarged disk. Basal depression is not pronounced, except in No. 8615, which has a somewhat deeply depressed base with radial grooves. Calyx is large and its lobes are well developed, except in No. 8615, which is somewhat like Owari. Blemishes are none, except that one-third of the total are affected by thrips. In conclusion, the lot is most attractive, having particularly a good size and a beautiful skin. No conical fruits are found, all being generally rectangular. Fruits are all more or less soft and heavy.

The cross-section has an equally thin rind, mostly uniform in thickness. Segments many, not conspicuously non-uniform; wall medium in thickness, as compared with the size of fruit. Central column rather large and contains abundant pith. Pulp deep-colored, extremely coarse grained, some quite solidified, vesicle wall is always distinct, even in the smallest one. Pulp crisp, sweet, but not juicy; some are extremely insipid but never bitterish. Two fruits contain seeds.

The insipid flavor of this Wase may not be a definite character, since this year the pulp tasted much better than in the previous year.

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\* PL. XXIX, Fig. 3.

TABLE 139.

MEASUREMENT OF 28 FRUITS (NOS. 1362-1389) FROM ISHIKAWA'S BUD  
VARIATION TREE (ISHIKAWA WASE) AT TOYODA-MURA,  
SHIDZUOKA-KEN. LOT NO. 11 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
25.59 cm.	6.20 cm.	1.31	202.11 gm.	12.00 cm.	11.68	2.83 mm.	17.93 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	28	—	—	—	—	—	25	89.29%
Sinuate based fruits	28	—	—	—	—	—	1	3.57
Semi-sinuate based fruits	28	—	—	—	—	—	6	21.43
Areolated fruits	28	—	—	—	—	—	3	10.71
Fra. with undeveloped calyx lobes	28	—	—	—	—	—	9	32.14
Fra. with long narrow calyx lobes	28	—	—	—	—	—	0	0
Fruits containing seeds	28	—	—	—	—	—	0	0
Apical depression	28	0 0	13 46.43	7 25.00	8 28.57%	—	—	—
Apical dots	28	0 0	9 32.14	19 67.86%	—	—	—	—
Flatness of fruit	28	0 0	6 21.43	19 67.86	3 10.71	0 0%	—	—
Smoothness of fruit	28	0 0	27 96.43	1 3.57	0 0	0 0%	—	—
Thinness of rind	28	27 96.43	1 3.57	0 0	0 0	0 0%	—	—
Thinness of segment wall	28	17 60.71	10 35.71	1 3.57	0 0	0 0%	—	—
Color of pulp	28	7 25.00	11 39.29	10 35.71	0 0	0 0%	—	—
Size of central column	28	1 3.57	5 17.86	9 32.14	10 35.71	3 10.71%	—	—
Quantity of pith	28	0 0	17 60.71	11 39.29	0 0	0 0%	—	—
Quality of pulp	28	8 28.57	14 50.00	6 21.43	0 0	0 0%	—	—

TABLE 140.

MEASUREMENT OF 31 WASE FRUITS (NOS. 8591-8621) FROM ISHIKAWA'S BUD  
VARIATION TREE (ISHIKAWA WASE) AT TOYODA-MURA,  
SHIDZUOKA-KEN. LOT NO. 125 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
25.00 cm.	5.71 cm.	1.39	193.58 gm.	11.50 mm.	10.78	2.65 mm.	15.64 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	31	—	—	—	—	—	29	% 93.55
Sinuate based fruits	31	—	—	—	—	—	5	16.13
Semi-sinuate based fruits	31	—	—	—	—	—	0	0
Areolated fruits	31	—	—	—	—	—	26	83.87
Frs. with undeveloped calyx lobes	30	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	30	—	—	—	—	—	0	0
Fruits containing seeds	31	—	—	—	—	—	2	6.45
Apical depression	31	1 3.23	4 12.90	20 64.52	6 19.35%	—	—	—
Apical dots	31	12 38.71	15 48.39	4 12.90%	—	—	—	—
Flatness of fruit	31	7 22.58	13 41.94	10 32.26	1 3.23	0 0%	—	—
Smoothness of fruit	31	10 32.26	21 67.74	0 0	0 0	0 0%	—	—
Thinness of rind	31	27 87.10	4 12.90	0 0	0 0	0 0%	—	—
Thinness of segment wall	31	6 19.35	15 48.39	9 29.03	1 3.23	0 0%	—	—
Color of pulp	31	25 80.65	6 19.35	0 0	0 0	0 0%	—	—
Size of central column	31	0 0	3 9.68	22 70.97	5 16.13	1 3.23%	—	—
Quantity of pith	31	1 3.23	24 77.42	6 19.35	0 0	0 0%	—	—
Quality of pulp	31	25 80.65	6 19.35	0 0	0 0	0 0%	—	—

This is possibly due to under-fertilization and better quality will probably result if tree is planted in a well fertilized orchard.

The measurements of fruit of this year are given in Table 140.\*

These tables show the remarkable size of the fruit.

## OWARI FRUITS FROM ISHIKAWA'S BUD VARIATION TREE

83 fruits (Nos. 1390-1472) from the Owari part (normal branches) of ISHIKAWA's bud variation tree (Ishikawa Wase) were collected in 1920 and were examined thoroughly. The following note was taken from the provisional observation.

Fruits are large-sized, ranging from large to medium-small, compact, rather tall in shape, varying from medium-flat to medium-high, and they very remarkably have a quite regular circular horizontal outline. Surface even, oil cell dots finely pitted. Base lightly depressed to strongly sinuate, and often double-rinded and radially striated, with comparatively large-sized disk. The basal grooves are all short and many, not like thick long grooves seen in the over-mature fruits of the average Owari fruits (or reversion fruits from Wase). Calyx rather large-sized and stem is thick. Apex either flat or shallowly depressed, without pronounced areola and navel mark. The characteristics of the whole fruit are compactness and apparent tallness.

The cross-section is characterized by thick rind, thick wall, large central column, light-colored pulp, great quantity of pith, very coarse but elongated vesicle arrangement, insipid or subacid taste, rounded segment ends, globose, rather dispersed, oil cells of the rind. Thickness of the segment wall is associated with hard pith which ties up several ends of the segments together. The vesiculation is entirely unlike the Wase, being all stretched, not forming a short reticulation: color of pulp is also much lighter than in Wase fruits. A few fruits (like No. 1895) have a thin rind, thin segment wall, and angular segment corners, and contain little pith and better tasting, deep-colored pulp. Average fruits have

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\* PL. XXX, Fig. 1.



brittle, much adhering rind, hard to remove. Seeds are found frequently. The fruit was just ripe when examined on Nov. 26, 1920.

The measurements of fruits are given in Table 141.\*

The Owari fruits from ISHIKAWA's bud variation tree were re-examined in 1924 and the following note was taken.

274 fruits (Nos. 8734-9007) were sent in. After an examination of the whole lot, 19 representative fruits (Nos. 8734-8753) were picked out, which were described as follows:

Size ranges from large to small, shape ranges from flat to high, smoothness also ranging from rough to smooth. Average fruit does not look rough, appearing rather even, but is not so polished as Wase. Shape uniform, horizontal outline round, usually not flat and more or less tall, but not so round as Ikeda fruits. Base always flattened, appearing very gradually concave or broadly depressed. Calyx not always strongly pressing the rind and consequently no deep radial grooves are present. Apex usually not concave, simply flattened, with dots reaching the stylar point. Areola and navel existing but not prominent, Color partly green but partly deep orange. Beautiful fruit in general appearance due to the regularity of shape. Pitting of the rind is not strong. The side view is not rectangular as in Wase fruit. The size is smaller than medium or is nearly medium. Height is medium rather than medium-flat.

The cross-sections of three largest fruits (Nos. 8734-8736) have rather thick rind, color of rind being more or less pink, and its texture is rather solid. Number of segments is not many, the shape is semi-uniform; segment wall is medium-thick. Pulp soft, meaty (not juicy), distinctly coarse grained, but the individual vesicles are elongated and are not anastomose. Taste is good, rich in flavor though not fully mature when examined (Nov. 11, 1924). The inner end of segment wall is rather pointed and two or three are in a group, fastened together by thick pith. It is typical Owari, although the vesicle arrangement is rather coarse. The cross-section of the rest of the representative fruits have rather uniformly thin rind; wall is medium-thin, none have a

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\* PL- XXX, Fig. 2.

TABLE 141.

MEASUREMENT OF 82 OWARI FRUITS (NOS. 1390-1471) FROM ISHIKAWA'S  
BUD VARIATION TREE (ISHIKAWA WASE) AT TOYODA-MURA,  
SHIDZUOKA-KEN. LOT NO. 12 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.66 cm.	5.36 cm.	1.28	125.84 gm.	10.02 mm.	10.56	2.92 mm.	16.51 mm

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	82	—	—	—	—	50	% 60.98
Sinuate based fruits	82	—	—	—	—	32	39.02
Semi-sinuate based fruits	82	—	—	—	—	8	9.76
Areolated fruits	82	—	—	—	—	12	14.63
Frs. with undeveloped calyx lobes	79	—	—	—	—	26	32.91
Frs. with long narrow calyx lobes	79	—	—	—	—	0	0
Fruit containing seeds	82	—	—	—	—	4	4.88
Apical depression	82	0 0	10 12.20	34 41.46	48 46.34%	—	—
Apical dots	82	0 0	1 1.22	81 98.78%	—	—	—
Flatness of fruit	82	0 0	14 17.07	51 62.20	17 20.73	0 0%	—
Smoothness of fruit	82	3 3.66	16 19.51	54 65.85	9 10.98	0 0%	—
Thinness of rind	82	19 23.17	20 35.37	27 32.93	6 7.32	1 1.22%	—
Thinness of segment wall	82	4 4.88	17 20.73	36 43.90	13 15.85	12 14.63%	—
Color of pulp	82	11 13.41	39 47.56	24 29.27	7 8.54	1 1.22%	—
Size of central column	82	11 13.41	31 37.80	33 40.24	7 8.54	0 0%	—
Quantity of pith	82	14 17.07	38 46.34	28 34.15	2 2.44	0 0%	—
Quality of pulp	82	4 4.88	29 35.37	37 45.12	8 9.76	4 4.88%	—

TABLE 142.

MEASUREMENT OF 274 OWARI FRUITS (NOS. 8734-9007) FROM ISHIKAWA'S  
BUD VARIATION TREE (ISHIKAWA WASE) AT TOYODA-MURA,  
SHIDZUOKA-KEN. LOT NO. 131 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.53 sm.	4.33 cm.	1.35	84.35 gm.	9.59 mm.	10.25	2.68 mm.	11.17 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	274	—	—	—	—	—	93	33.94
Sinuate based fruits	274	—	—	—	—	—	45	16.42
Semi-sinuate based fruits	274	—	—	—	—	—	0	0
Areolated fruits	274	—	—	—	—	—	164	59.85
Frs. with undeveloped calyx lobes	274	—	—	—	—	—	44	16.06
Frs. with long narrow calyx lobes	274	—	—	—	—	—	2	0.73
Fruits containing seeds	274	—	—	—	—	—	24	8.76
Apical depression	274	0 0	22 8.03	163 59.49	89 32.48%	—	—	—
Apical dots	274	10 3.64	60 21.90	204 74.45%	—	—	—	—
Flatness of fruit	274	7 2.55	73 26.64	138 50.36	45 16.42	11 4.01%	—	—
Smoothness of fruit	274	15 5.47	155 56.57	91 33.21	13 4.74	0 0%	—	—
Thinness of rind	274	72 26.28	123 44.89	71 25.91	8 2.92	0 0%	—	—
Thinness of segment wall	273	46 16.85	156 57.14	63 23.08	5 1.83	3 1.09%	—	—
Color of pulp	273	13 4.74	84 30.66	111 40.51	54 19.71	11 4.01%	—	—
Size of central column	274	9 3.28	44 16.06	155 56.57	58 21.17	8 2.92%	—	—
Quantity of pith	273	35 12.77	155 56.57	80 29.20	3 1.09	0 0%	—	—
Quality of pulp	263	10 3.80	44 16.73	121 46.01	63 23.95	25 9.51%	—	—

remarkably thick rind. The central column is medium in size, none being small. Pith not much. Color usually deep or medium-deep. Taste is generally better than medium-good, some large fruits are really excellent, only acidulous in the smaller members. Pulp vesicles are large but elongated, not forming a net-work and in some small fruit they are quite parallel. It has a thinner rind and better quality than the average Owari fruit.

The measurements of fruits are given in Table 142.\*

A number of fruits of the Owari from ISHIKAWA's bud variation tree received in 1924 were stored until the end of February and kept perfectly well.

Running over the majority of the fruits, it is noted that they are roundish, often very high, with flattened base, shallowly sinuate at the calyx and with simply flattened or even roundish apex without naked area around the stylar point in general. The outline is remarkably regular and the rind is adherent, even, sparingly dotted, and medium in thickness. Pulp is light-colored, rarely deep, at most remaining in medium-deep degree; segment wall is thick and pith is generally much while the flavor is medium, mostly being insipid. In smaller or not fully mature fruits, the juice is often acidic and bitterish, and only about 30 per cent are sweet in taste. It is not definitely known whether the comparative insipid flavor of both Wase and Owari fruits of the same tree is due to the under-fertilization or to the real character of the tree. Although both kinds of fruit are beautiful in shape and size, the real merit is doubtful in this particular respect.

### **HORIE'S BUD VARIATION WASE SATSUMA IN SHIDZUOKA-KEN**

Mr. Kanesuke HARA obtained information in 1920 that there is another bud variation Wase tree existing in the belonging to orchard Hikoichirô HORIE, at Shichôjima, Nishimashidzu-mura, Shida-gun,

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\* PL. XXX, Fig 8.

Shidzuoka-ken (PL. LI, Fig. 8). The tree was visited by the author on Nov. 6, 1920 and the following note was taken.

The orchard is a flat-land planted with Satsuma oranges at a distance of 3.5 m. apart. The tree in question is located at the north-western corner of the orchard, the 5th from the north and the 2nd from the west. This tree was propagated about 1885 and was transplanted here three years later. It has a N-S spread of 4 m. an E-W spread of 3.65 m. and a height of 2.3 m. The tree is a regular Owari Satsuma with open head, and rather low branches spreading sidewise. The north side has more branches than the other side. The trunk is straight and upright, divided into two at 28 cm. from the ground, the girth of the lowermost part being 76 cm. and that of the bottom below the division being 24 cm. The thicker and more straight main branch-trunk turns to the S-E at a height of 81 m. from the ground and at this spot a long slim shoot runs out over 1.45 m. in length. This shoot is forked at a distance of 17 cm. from the bottom and the southern limb of 1.9 m. in length is straight Owari, while the northern limb of 1.3 m. in length is Wase. The leaves on the latter limb are slightly smaller and somewhat resemble Kawano Wase, while the rest are large, appearing true to Owari. The bud of the tree possibly came from the oldest Satsuma garden of this region, belonging to Jûemon SHIBATA of Miwa, Okabe-chô, in Shidzuoka Prefecture, and it was grafted on Yuzu stock by Yoemon SUGIYAMA, as far as the present owner remembers. The bud variation was first noticed by the owner in 1917 and the fruit generally starts coloring from October 10th. The branch was not affected by the saline wind which attacked the tree in 1916. The soil condition is fair, being a dark-colored loam without pebbles and is rich in organic matter. Fertilizers applied per 5 sé (4.95 ares) are 7.5 kwan (28.1 kg.) of fish, 10 kwan (37.5 kg.) of sesamum cake, 2 kwan (7 kg.) of Ammonium sulphate, 10 kwan (37.5 kg.) of superphosphate of lime, 170 kwan (637.5 kg.) of stable manure, 37 kwan (138.9 kg.) of wood ash and 11 kwan (41.3 kg.) of lime.

The total crop of 39 fruits of the Wase branch and 48 Owari fruits of a single branch from the southern side were collected for study. An account of these fruits is written down in the following notes :

The Wase fruits are not very large in size but are distinctly larger and more round than the rest. The Owari fruits are smaller in size, compact, rather regular in outline and still very greenish. The Wase fruits, on the other hand, are well ripened, already becoming more or less baggy and soft. The base of the Owari fruit is flat, mostly rather abruptly truncate and shallowly concave, while in the Wase fruit it is only slightly depressed and is somewhat grooved. The apex is much concave in the Owari fruit, but only shallowly so or merely flat in the Wase. The surface is even in the Wase but pitted in the Owari. The oil cell dots are larger and are all convex in the former. The Wase fruit lacks the luxuriant development of the disk but the calyx is decidedly larger than that of the Owari fruit. The development of the navel is more pronounced in the Owari fruit, and in both lots oil cell dots reach the stylar point without leaving a naked area around the stylar point, areola is not prominent in both. No sour scab infection is found, but thrips and scale insects are bad.

In cross-section, the Wase fruits have apparently a smaller number of segments, each segment having a rounded outer end and a more or less rounded-triangular inner end. Segments of the Owari fruits have wavy outer ends and triangular inner ends. The rind of the Wase fruits is thinner, but more or less thicker than the average Kawano Wase, partly due to over-maturity. The Wase fruits have a brittle rind, large oil cells, rounded corners of segments, and more or less larger-sized central columns, not similar to those of the Kawano Wase, but the larger pulp vesicles, meaty and easily drying, and early ripening in nature, are undoubtedly Wase. In the Owari fruits, oil cells are much smaller, more crowded, and lighter colored, and many of them have a thicker rind than the Wase fruits. The pulp of the Owari fruits is juicy, fine grained, and does not dry easily. They have thin segment walls, a large number of segments, small amount of pith, and more or less light-colored, scidulous pulp.

The measurements of both lots of fruit are given in Tables 143\* and 144.\*\*

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\* PL. XXXI, Fig. 1.

\*\* PL. XXXI, Fig. 2.

TABLE 143.

MEASUREMENT OF 39 WASE FRUITS (NOS. 1517-1555) OF HORIE'S BUD VARIATION TREE (HORIE WASE) AT NISHIMASHIDZU, SHIDA-GUN, SHIDZUOKA-KEN. LOT NO. 13 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.96 cm.	5.07 cm.	1.32	112.96 gm.	10.95 mm.	10.08	2.99 mm.	14.00 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	39	—	—	—	—	—	8	% 20.51
Sinuate based fruits	39	—	—	—	—	—	2	5.13
Semi-sinuate based fruits	39	—	—	—	—	—	5	12.82
Areolated fruits	39	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	38	—	—	—	—	—	17	44.74
Frs. with long narrow calyx lobes	38	—	—	—	—	—	0	0
Fruits containing seeds	39	—	—	—	—	—	0	0
Apical depression	39	3 7.69	8 20.51	11 28.21	17 43.59%	—	—	—
Apical dots	39	0 0	4 10.26	35 89.74%	—	—	—	—
Flatness of fruit	39	0 0	5 12.82	26 66.67	8 20.51	0 0%	—	—
Smoothness of fruit	39	6 15.38	33 84.62	0 0	0 0	0 0%	—	—
Thinness of rind	39	23 58.97	12 30.77	4 10.26	0 0	0 0%	—	—
Thinness of segment wall	39	24 61.54	12 30.77	3 7.69	0 0	0 0%	—	—
Color of pulp	39	17 43.59	22 56.41	0 0	0 0	0 0%	—	—
Size of central column	39	0 0	5 12.82	24 61.54	10 25.64	0 0%	—	—
Quantity of pith	39	0 0	2 5.13	28 71.79	9 23.08	0 0%	—	—
Quality of pulp	39	25 64.10	13 33.33	1 2.56	0 0	0 0%	—	—

TABLE 144.

MEASUREMENT OF 45 OWARI FRUITS (NOS. 1472-1516) OF HORIE'S BUD  
VARIATION TREE (HORIE WASE) AT NISHIMASHIDZU, SHIDA-GUN,  
SHIDZUOKA-KEN. LOT NO. 14 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.95 cm.	4.46 cm.	1.35	83.95 gm.	10.20 mm.	11.02	2.73 mm.	12.98 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	44	—	—	—	—	—	26	% 59.09
Sinuate based fruits	45	—	—	—	—	—	8	17.78
Semi-sinuate based fruits	45	—	—	—	—	—	3	6.67
Areolated fruits	45	—	—	—	—	—	2	4.44
Frs. with undeveloped calyx lobes	44	—	—	—	—	—	22	50.00
Frs. with long narrow calyx lobes	44	—	—	—	—	—	0	0
Fruit containing seeds	45	—	—	—	—	—	0	0
Apical depression	45	7 15.56	22 48.89	10 22.22	6 13.33%	—	—	—
Apical dots	45	0 0	1 2.22	44 97.78%	—	—	—	—
Flatness of fruit	45	0 0	10 22.22	27 60.00	8 17.78	0 0%	—	—
Smoothness of fruit	45	0 0	14 31.11	30 66.67	1 2.22	0 0%	—	—
Thinness of rind	45	15 33.33	18 40.00	8 17.78	4 8.89	0 0%	—	—
Thinness of segment wall	45	33 73.33	11 24.44	1 2.22	0 0	0 0%	—	—
Color of pulp	45	11 24.44	28 62.22	5 11.11	1 2.22	0 0%	—	—
Size of central column	45	1 2.22	6 13.33	30 66.67	8 17.78	0 0%	—	—
Quantity of pith	45	0 0	2 4.44	29 64.44	13 28.89	1 2.22%	—	—
Quality of pulp	45	5 11.11	21 46.67	17 37.78	2 4.44	0 0%	—	—



In comparing these tables, the Wase fruits are larger, taller, and have a larger calyx, a small number of segments, and a small number of naveled fruits. Although the rind is slightly thick in the absolute figure in the Wase, the relative thinness is rather more pronounced in the Wase than in the Owari. As to the central column, the same relation exists, and smaller ones are more in number in the Wase than in the Owari. The pith is slightly less in quantity in the Wase and the difference in flavor is rather significant.

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## **BOOK VII**



## STUDIES IN THE BUD VARIATION OF THE SATSUMA ORANGE

### *II. The Second Period of Discovery*

#### **NAGATA WASE, THE FIRST BUD VARIATION WASE SATSUMA FOUND AT MIKKABI, SHIDZUOKA-KEN**

In November, 1920, the writer's attention was called by Prof. T. ONDA, director of the Imperial Horticultural Experiment Station at Okitsu, to a fruit that he claimed was originated through bud mutation. The season was too late to make a thorough examination of the tree and only a study of two fruits offered by Prof. ONDA was made. In conversation, the writer learned that the tree has a lower branch entirely different from the limb which was bearing these fruits and afterwards this was confirmed by an actual inspection by Mr. Kanesuke HARA, who found that the plant is dual in nature as was told by Prof. ONDA, but the nature of the crop of the unchanged part was unknown. The tree was then said to have been found at Bunzu, Mikkabi-chô, Inasa-gun, Shidzuoka-ken, but name of the owner of the tree was not told. This Wase was therefore provisionally called Inasa Wase in the author's manuscript and communication.

The fruits examined (Nos. 1916, 1917) were tall, medium, or medium-high in grade, smooth but dotted with large oil cells, and beautifully orange-colored. The apex was rather broadly depressed, areolated or non-areolated, a few dots reaching to the styler point, navel present or absent. The base was shallowly concave and double ringed, with a somewhat enlarged disk. The calyx was normal. The cross-section showed a thin rind, medium-thin wall, medium-small central column, medium-little pith and deep-colored, pleasantly flavored pulp of good quality. The measurements of fruit are given in Table 145.

TABLE 145.

MEASUREMENT OF TWO FRUITS (NOS. 1916-1917; FROM BUNZU, LATER CALLED NAGATA WASE (INASA WASE IN MSS.) STUDIED IN 1920 AT OKITSU.

Av. Girth	Av. Height	D/H Index	Weight	Calyx	Disk	No. Segm'ts.	Rind	Center
20.90 cm.	5.20 cm.	1.23	124.00 gm.	mm. 11.00	7.50 mm.	11.00	2.50 mm.	12.25 mm.

On Nov. 7, 1923, the writer first visited the village of Mikkabi and saw Mr. Ken'itsu MATSUI. This was the first step in the future wonderful development of the study of Wase.

On this visit the writer found that the plant showing the bud variation belongs to Fusaji NAGATA of Bunzu, Okamoto, Mikkabi-chô, Inasagun, Shidzuoka-ken. It was confirmed that the tree was visited by Prof. ONDA in 1920 and the fruits given above were taken from this tree. The tree is found on the first row, the third tree from the corner of the path leading to the border road parallel to the row (PL. LI, Fig. 9). This plot is at the eastern end of a flat-land orchard east of the house. The plant looked very ill due to an attack of stem-borer, and it was already found that one northern trunk, which is said to have been Wase, was lost. There are two remaining trunks and the southern one bears only leaves which look to be in very poor condition. The central trunk is upright, moderately curved, it is 41 cm. from the ground to the first main branch, 46 cm. to the second branch. This also looks poor and it seems it will not live long. The total E-W spread of the tree is 2.3 m., that of N-S spread 1.45 m. and it is 1.75 m. in height, the tree being planted at a distance of  $3.5 \times 2.9$  m. from other trees. This central trunk spreads toward the north, bearing small, boat-shaped, abnormal, ill leaves, so that it is hard to tell what is their characteristic shape and size. These leaves are not lozenge-shaped, but are slightly rounded at the apex and are twisted at the middle. A few spines are found on a watersprout springing up from the top of the tree. The southern trunk, which is said to be Owari, has no fruit, but the statement of the intelligent wife of the owner agrees with that of Prof. ONDA, that it matures a great deal later than the other trunks. The soil is light-colored loam, with a large quantity of small gravel, apparently it is not very fertile.

Fertilizers consisting of bean cake, super-phosphate, and bone dust are applied at a ratio 2 shô (3.6 litres) per tree. This is a purchased tree and it is not known from where it came. The fruit in question is said to mature about 20 days earlier than the others. The neighboring trees are typical Owari bought from Aichi Prefecture (Owari Province), and are very vigorous, being about 3.5 m. wide and 2.9 m. high, with typical, large, hanging leaves. The fruits on these trees are rather roundish, possibly due to a severe infection of sour scab and rust mite. The fruits of the variation branch are conspicuously deeper colored, though they are smaller and more roundish, due to the unhealthy condition of the plant. These Wase fruits have a smooth skin and a particularly deep color around the calyx, as has Kawano Wase, although the disk is not much enlarged.

Fifty-three fruits were picked from the original tree on November 7, 1923. (Nos. 7231-7264 from the main limb, Nos. 7265-7276 from the southern limb, and Nos. 7277-7283 from the eastern limb). The description of these fruits is given below:

Fruits medium to small (due to abnormal condition of the tree); shape of medium grade, appearing rather tall; surface smooth; oil cell dots large, convex, and distinct as characteristic of Wase. Base is rounded, rarely slightly concave, mostly with radiating striations of oil cell dots. Disk is distinct, not enlarged nor without clear demarcation, so that many fruits appear sinuous at the calyx. Size of the calyx is normal, not large, lobes not fully developed, not elongate, most with thin margins; body (tube part) not thickened. Apex slightly depressed, oil cells not many around the styler point, areola exists, and navel is not generally developed. Rust, melanose, and other blemishes are many, and the percentage of perfect fruits does not amount to one-third of the whole lot. The fruit is fully mature and has a very tight skin.

The cross-section shows a very thin rind, not abundant segments, more or less thick segment wall, small center, medium amount of pith, very deep-colored, coarse grained, melting pulp of remarkably good quality.

TABLE 146.

MEASUREMENT OF 53 WASE FRUITS (NOS. 7231-7283) OF NAGATA'S ORIGINAL  
BUD VARIATION TREE AT MIKKABI, SHIDZUOKA PREFECTURE,  
STUDIED IN 1923 (LOT NO. 100)

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.12 cm.	3.90 cm.	1.32	57.42 gm.	8.70 mm.	10.51	1.73 mm.	9.38 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	53	—	—	—	—	—	1	% 1.89
Sinuate based fruits	53	—	—	—	—	—	28	54.90
Semi-sinuate based fruits	53	—	—	—	—	—	0	0
Areolated fruits	53	—	—	—	—	—	20	37.74
Frs. with undeveloped calyx lobes	51	—	—	—	—	—	4	12.90
Frs. with long narrow calyx lobes	51	—	—	—	—	—	0	0
Fruits containing seeds	53	—	—	—	—	—	7	13.21
Apical depression	53	0 0	31 58.49	22 41.51	0 0%	—	—	—
Apical dots	53	5 9.43	30 56.60	18 33.96%	—	—	—	—
Flatness of fruit	53	2 3.77	15 28.30	32 60.38	3 5.66	1 1.89%	—	—
Smoothness of fruit	53	17 32.08	35 66.04	1 1.89	0 0	0 0%	—	—
Thinness of rind	53	53 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	53	31 58.49	20 37.74	2 3.77	0 0	0 0%	—	—
Color of pulp	53	36 67.92	16 30.19	1 1.89	0 0	0 0%	—	—
Size of central column	53	0 0	1 1.89	21 39.62	22 41.51	9 16.98%	—	—
Quantity of pith	53	1 1.89	18 33.96	33 62.26	1 1.89	0 0%	—	—
Quality of pulp	51	28 54.90	14 27.46	9 17.65	0 0	0 0%	—	—

The measurements of these fruits are given in Table 146.\*

There are a few second generation trees of this Wase Satsuma. A tree top-worked upon an Owari Satsuma found in NAGATA'S orchard was first examined (PL. II, Fig. 10). This tree is located at the south of the front of the house, being the corner tree facing a vegetable garden. The tree is 2.6 m. in diameter, and is planted at a distance of 3.5 m. from the neighboring trees. The top-worked branches, three in all, are found two on the southernmost trunk and one on the northernmost trunk, all being top-grafted in 1921 by Mr. Sôtârô NAKAGAWA, of the Kainan Plantation Company of the same village. These branches are very elongated and drooping, having very close nodes and small twisted leaves characteristic of Wase. The fruits are comparatively small with full-colored skin, mostly attacked by rust and mite, but the tree is very heavily loaded.

Another tree top-worked by the same person was found in the orchard of Tahei SATÔ, near NAGATA'S house (PL. II, Fig. 11). This is in the first row from the house and the third tree from the west. The E-W spread of the tree is 1.2 m., N-S spread is 1.7 m., and the height is 1.2 m. The whole tree was top-worked in 1921 and 1922, and the branches are long, spreading in various directions, with very narrow internodes and very crowded foliage. The leaves are small, very dense, characteristically broad and twisted, but look vigorous and are dark green. The fruits of this tree are large, still greenish and rough. Calyx is large and the stem-end very often double-ringed, resembling that of Kawano Wase. Navel is more pronounced than in the others. Measurements of the fruit of these two second generation trees are given in Tables 147\* and 148.\*\*

These figures show that the fruits in every lot are rather tall and have rather dominating basal sinuations. Calyx seems normal in the average and the skin is fairly thin. The poor development of the navel mark in the first two lots may be due to the condition of the tree, be-

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\* PL. XXXI, Fig. 3, 4 & 5.

\*\* PL. XXXII, Fig. 1.

\*\*\*PL. XXXII, Fig. 2.



TABLE 147.

MEASUREMENT OF 45 FRUITS (NOS. 7234-7328) FROM A NAGATA WASE SECOND GENERATION TREE IN NAGATA'S ORCHARD AT MIKKABI, SHIDZUOKA-KEN, LOT NO. 101 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.14 cm.	4.56 cm.	1.27	82.40 gm.	9.95 mm.	10.48	2.32 mm.	10.07 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	45	—	—	—	—	—	1	% 2.22
Sinuate based fruits	45	—	—	—	—	—	18	40.00
Semi-sinuate based fruits	45	—	—	—	—	—	8	17.78
Areolated fruits	45	—	—	—	—	—	21	46.67
Frs. with undeveloped calyx lobes	40	—	—	—	—	—	5	12.50
Frs. with long narrow calyx lobes	40	—	—	—	—	—	0	0
Fruits containing seed	44	—	—	—	—	—	3	6.82
Apical depression	45	3 6.67	21 46.67	21 46.67	0 0%	—	—	—
Apical dots	45	18 40.00	27 60.00	0 0%	—	—	—	—
Flatness of fruit	45	0 0	1 2.22	14 31.11	24 53.33	6 13.33%	—	—
Smoothness of fruit	45	21 46.67	21 46.67	3 6.67	0 0	0 0%	—	—
Thinness of rind	44	37 84.09	4 9.09	3 6.82	0 0	0 0%	—	—
Thinness of segment wall	44	30 68.18	12 27.27	2 4.55	0 0	0 0%	—	—
Color of pulp	44	40 90.91	4 9.09	0 0	0 0	0 0%	—	—
Size of central column	44	0 0	3 6.82	17 38.64	16 36.36	8 18.18%	—	—
Quantity of pith	44	1 2.27	5 11.36	35 79.55	1 2.27	2 4.55%	—	—
Quality of pulp	42	28 66.67	14 33.33	0 0	0 0	0 0%	—	—

TABLE 148.

MEASUREMENT OF 35 FRUITS (NOS. 7329-7363) FROM A NAGATA WASE SECOND GENERATION TREE IN SATO'S ORCHARD AT MIKKABI, SHIDZUOKA-KEN, LOT NO. 102 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.13 cm.	4.97 cm.	1.29	110.94 gm.	10.34 mm.	10.63	2.69 mm.	12.34 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	35	—	—	—	—	—	18	% 51.43
Sinuate based fruits	35	—	—	—	—	—	7	20.00
Semi-sinuate based fruits	35	—	—	—	—	—	6	17.14
Areolated fruits	35	—	—	—	—	—	15	42.86
Frs. with undeveloped calyx lobes	35	—	—	—	—	—	4	11.43
Frs. with long narrow calyx lobes	35	—	—	—	—	—	0	0
Fruits containing seeds	35	—	—	—	—	—	0	0
Apical depression	35	<sup>12</sup> 34.29	<sup>21</sup> 60.00	<sup>2</sup> 5.71	<sup>0</sup> 0%	—	—	—
Apical dots	35	<sup>12</sup> 34.29	<sup>15</sup> 42.86	<sup>8</sup> 22.86%	—	—	—	—
Flatness of fruit	35	<sup>5</sup> 14.29	<sup>7</sup> 20.00	<sup>17</sup> 48.57	<sup>6</sup> 17.14	<sup>0</sup> 0%	—	—
Smoothness of fruit	35	<sup>2</sup> 5.71	<sup>19</sup> 54.29	<sup>14</sup> 40.00	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Thinness of rind	35	<sup>22</sup> 62.86	<sup>13</sup> 37.14	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Thinness of segment wall	35	<sup>23</sup> 65.71	<sup>7</sup> 20.00	<sup>5</sup> 14.29	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Color of pulp	35	<sup>21</sup> 60.00	<sup>14</sup> 40.00	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Size of central column	35	<sup>1</sup> 2.86	<sup>3</sup> 8.57	<sup>19</sup> 54.29	<sup>9</sup> 25.71	<sup>3</sup> 8.57%	—	—
Quantity of pith	35	<sup>0</sup> 0	<sup>1</sup> 8.57	<sup>19</sup> 54.29	<sup>11</sup> 31.43	<sup>2</sup> 5.71%	—	—
Quality of pulp	35	<sup>30</sup> 85.71	<sup>4</sup> 11.43	<sup>1</sup> 2.81	<sup>0</sup> 0	<sup>0</sup> 0%	—	—

cause this character is rather conspicuous in the last lot, which has fruit of normal size.

The crops of the original tree and of the second generation tree in NAGATA's orchard were re-examined in 1924 and the following note was taken when the fruits were received.

Original tree: 12 fruits (Nos. 9145-9156), forming the total crop, were investigated.

Fruits ranging from medium to small, smooth and flat. Some fruits have abnormal basal protrusions, being a sign of the very much weakened condition of the tree. Apex simply flattened or slightly concave, and many fruits are areolated and provided with dots around the styler point. Base often sinuate and the disk entirely undeveloped. Calyx small, normal, fine striations radiating from it generally lacking. Oil cell dots very much dispersed, generally prominent, with a few exceptions. Basal half of the fruit is particularly smooth coloring poor, light, none of the fruit having a bright color.

The cross-section shows signs of degeneration due to the dying condition of the tree. The rind is thin, brittle, oil cells far apart. Segments rather few (except in No. 9156, which has 13 segments), and irregular. Central column medium in size, in some irregular. Pith is abundant and solid, running into the space between the segments. Pulp juicy but light-colored, none having bright color; vesiculation coarse, invisible, taste medium, often very bitter.

Top-worked second generation tree in NAGATA's orchard; the whole crop of 60 fruits (Nos. 9058-9117) was studied.

Size of fruit varies from large to small, coming from branches of different strength, usually rounded but not conical, generally more or less roughened and greenish (probably by the infection of sooty mould), smaller fruits are rather smooth and polished, oil cell dots large, sometimes with a distinct margin in larger fruits. Depression of the apex is rather pronounced; areola not much developed, navel moderately developed. Base usually flattened, a great many of the fruit have a double ring. Calyx small, normal, fine striations around it not conspicuous; disk developed, much enlarged in larger fruits.

TABLE 149.

MEASUREMENT OF 12 FRUITS (NOS. 9145-9156) FROM NAGATA WASE ORIGINAL TREE AT MIKKABI, SHIDZUOKA-KEN, LOT NO. 136 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.68 cm.	4.08 cm.	1.45	78.17 gm.	9.90 mm.	9.67	1.67 mm.	11.13 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	12	—	—	—	—	—	3	% 25.00
Sinuate based fruits	12	—	—	—	—	—	8	66.67
Semi-sinuate based fruits	12	—	—	—	—	—	0	0
Areolated fruits	12	—	—	—	—	—	10	83.33
Frs. with undeveloped calyx lobes	12	—	—	—	—	—	1	8.33
Frs. with long narrow calyx lobes	12	—	—	—	—	—	0	0
Fruits containing seeds	12	—	—	—	—	—	1	8.33
Apical depression	12	0 0	10 83.33	2 16.67	0 0%	—	—	—
Apical dots	12	3 25.00	7 58.33	2 16.67%	—	—	—	—
Flatness of fruit	12	6 50.00	6 50.00	0 0	0 0	0 0%	—	—
Smoothness of fruit	12	3 25.00	6 50.00	3 25.00	0 0	0 0%	—	—
Thinness of rind	12	12 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	12	0 0	6 50.00	5 41.67	1 8.33	0 0%	—	—
Color of pulp	12	5 41.67	6 50.00	0 0	1 8.33	0 0%	—	—
Size of central column	12	0 0	1 8.33	6 50.00	3 25.00	2 16.67%	—	—
Quantity of pith	12	3 25.00	4 33.33	5 41.67	0 0	0 0%	—	—
Quality of pulp	12	0 0	3 25.00	6 50.00	3 25.00	0 0%	—	—

TABLE 150

MEASUREMENT OF 60 FRUITS (NOS. 9058-9117) OF NAGATA WASE SECOND GENERATION TREE (OLD EXAMPLE) IN NAGATA'S ORCHARD, SHIDZUOKA PREFECTURE, LOT NO. 134 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.09 cm.	4.69 cm.	1.36	105.48 gm.	11.08 mm.	10.23	2.53 mm.	10.58 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	60	—	—	—	—	—	21	35.00%
Sinuate based fruits	60	—	—	—	—	—	4	6.67
Semi-sinuate based fruits	60	—	—	—	—	—	0	0
Areolated fruits	60	—	—	—	—	—	20	33.33
Frs. with undeveloped calyx lobes	60	—	—	—	—	—	10	16.67
Frs. with long narrow calyx lobes	60	—	—	—	—	—	0	0
Fruits containing seeds	60	—	—	—	—	—	0	0
Apical depression	60	14 23.33	28 46.67	18 30.00	0 0%	—	—	—
Apical dots	60	20 33.33	35 58.33	5 8.33%	—	—	—	—
Flatness of fruit	60	4 6.67	17 28.33	30 50.00	7 11.67	2 3.33%	—	—
Smoothness of fruit	60	19 31.67	26 43.33	14 23.33	1 1.67	0 0%	—	—
Thinness of rind	60	45 75.00	15 25.00	0 0	0 0	0 0%	—	—
Thinness of segment wall	60	37 61.67	15 25.00	6 10.00	2 3.33	0 0%	—	—
Color of pulp	60	50 83.33	10 16.67	0 0	0 0	0 0%	—	—
Size of central column	60	0 0	0 0	18 30.00	24 40.00	18 30.00%	—	—
Quantity of pith	60	0 0	9 15.00	30 50.00	19 31.67	2 3.33%	—	—
Quality of pulp	60	36 60.00	19 31.67	5 8.33	0 0	0 0%	—	—

The cross-section shows a thin or medium-thin rind, and mostly medium-thin segment walls, together with a smaller central column with abundant pith. Color of pulp and quality of fruit is normal, fairly uniform, deeply colored, not bitter at all. The fruit with a small amount of pith (No. 9096) has a better taste. The average small fruits have a better quality, but the extremely small members are very inferior. The large fruit has a coarse rind, coarse vesicles, and a thick wall, as well as poor quality (insipid flavor). Generalizing, the taste is not intense although the fruit is fairly juicy. The segment wall is soft and weak, readily breaking.

Measurements of these lots of fruits for 1924 are given in Tables 149\* and 150.\*\*

A new top-worked tree (a single branch) was studied also in 1924 (PL. LI, Fig. 12). The tree is located at the corner of the farm just at the east of Mr. NAGATA's house. This is a Satsuma tree of about  $3.5 \times 2.6 \times 1.7$  cm., a southern branch being top-worked. The top-worked branch is three years old and bears characteristic Wase leaves. The grafted point is about 58 cm. from the ground, 69 cm. from the base. The tree is mulched with straw. Twenty-seven fruits were picked from this tree (Nos. 9118-9144). The description of these fruits is given below:

Fruit large, no small ones, grading uniformly. Most of the fruits are tall, much different from those on the original tree and are conical. Apex mostly flattened, or sometimes rounded, not concave. Areola not prominent, except in a few fruits like No. 9120. Base simply broad concave, shallow, rarely sinuous, very often with double ring, especially in larger ones. Navel not prominent. Every one has large and pronounced oil cell dots, some flat, some border-lined, and rarely concave, forming pits (No. 9120). Color varying from greenish to bright orange, generally light-colored; small members usually smooth and oily with very large dots. Calyx large, but the lobes not conspicuously elongated, broadened disks shown large members, and with typical fine radial striations from the calyx.

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\* PL XXXI, Fig. 6.

\*\* PL. XXXII, Fig. 3.

TABLE 151.

MEASUREMENT OF 27 FRUITS (NOS. 9118-9144) OF NEW SECOND GENERATION  
TREE OF THE NAGATA WASE IN NAGATA'S ORCHARD, SHIDZUOKA  
PREFECTURE. LOT NO. 135 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.52 cm.	5.07 cm.	1.35	131.93 gm.	10.78 mm.	10.04	2.82 mm.	11.22 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	27	—	—	—	—	—	10	37.04%
Sinuate based fruits	27	—	—	—	—	—	5	18.52
Semi-sinuate based fruits	27	—	—	—	—	—	0	0
Areolated fruits	27	—	—	—	—	—	7	25.93
Frs. with undeveloped calyx lobes	27	—	—	—	—	—	5	18.52
Frs. with long narrow calyx lobes	27	—	—	—	—	—	0	0
Fruits containing seeds	27	—	—	—	—	—	0	0
Apical depression	27	<sup>2</sup> 7.41	<sup>2</sup> 7.41	<sup>15</sup> 55.56	<sup>8</sup> 29.62%	—	—	—
Apical dots	27	<sup>17</sup> 62.96	<sup>9</sup> 33.33	<sup>1</sup> 3.70%	—	—	—	—
Flatness of fruit	27	<sup>3</sup> 11.11	<sup>3</sup> 11.11	<sup>11</sup> 40.74	<sup>9</sup> 33.33	<sup>1</sup> 3.70%	—	—
Smoothness of fruit	27	<sup>0</sup> 0	<sup>14</sup> 51.85	<sup>6</sup> 22.22	<sup>7</sup> 25.93	<sup>0</sup> 0%	—	—
Thinness of rind	27	<sup>10</sup> 37.04	<sup>11</sup> 40.74	<sup>6</sup> 22.22	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Thinness of segment wall	27	<sup>5</sup> 18.52	<sup>10</sup> 37.04	<sup>7</sup> 25.93	<sup>3</sup> 11.11	<sup>2</sup> 7.41%	—	—
Color of pulp	27	<sup>12</sup> 44.44	<sup>13</sup> 48.15	<sup>2</sup> 2.41	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Size of central column	27	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0	<sup>16</sup> 59.26	<sup>11</sup> 40.74%	—	—
Quantity of pith	27	<sup>4</sup> 14.81	<sup>14</sup> 51.85	<sup>9</sup> 33.33	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Quality of pulp	27	<sup>16</sup> 59.26	<sup>6</sup> 22.22	<sup>4</sup> 14.81	<sup>1</sup> 3.70	<sup>0</sup> 0%	—	—

The cross-section shows a thin to medium-thin rind, a usually more or less thick segment wall, small central column and much pith, as usual. Color and quality of pulp vary; some are light-colored (No. 9125) and of bad quality, some are better (No. 9130), the smaller ones are generally better, being associated with a thin rind and deep color of the pulp. Vesiculation is coarse, fruit not drying, all equally juicy and more or less insipid.

The measurements of fruits of this lot are given in Table 151.\*

In 1925, the original tree was again examined. It was still alive, and sprouting was seen from the Owari part below. No crop was found on the Wase part of the tree. Seven fruits were received from the above mentioned top-worked tree (Nos. 10262-10268). The description follows:

Fruit extremely large-sized, tall, shoulder not high, often conical at the base. Apex rounded, styler end flat or shallowly concave, often more or less convex, with almost no naked area around the styler point. Areola sometimes prominent (as in No. 2623). The base shows good Wase characters, calyx large, disk also large and its demarcation not clear, and having a very prominent, large, double ring often associated with radial furrows. Surface rough with prominent oil cell dots and deep fovea, no fruit with smooth skin. Well colored but still green patches are scattered in small areas. Some fruit is very bright-colored (No. 10267). Navel present in a few fruits. The whole lot, as Wase, looks rather unusual in its appearance, compactness and weight, but this is possibly due to the enormous size of the fruit borne on a very vigorous shoot.

The cross-section: Rind rather thick, oil cells remarkably large, distinct, occupying nearly one-half of the total thickness of the rind. Segment wall thick, especially so near the center. Central column small, very pithy. Pulp deep-colored, exceedingly coarse grained and solidifying, the vesicle wall becoming thick, white, and very distinct. The character of the pulp is hard, less juicy, slightly acidulous but not insipid, having a

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\* PL. XXXIII, Fig. 1.



TABLE 152.

MEASUREMENT OF 7 FRUITS (NOS. 10262-10268) FROM NEW SECOND GENERATION  
TREE OF THE NAGATA WASE IN NAGATA'S ORCHARD, SHIDZUOKA  
PREFECTURE, LOT NO. 168 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
24.36 cm.	6.20 cm.	1.26	160.57 gm.	12.29 mm.	10.71	3.60 mm.	13.00 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	7	—	—	—	—	—	4	57.14%
Sinuate based fruits	7	—	—	—	—	—	0	0
Semi-sinuate based fruits	7	—	—	—	—	—	0	0
Areolated fruits	7	—	—	—	—	—	3	42.86
Frs. with undeveloped calyx lobes	7	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	7	—	—	—	—	—	0	0
Fruits containing seeds	7	—	—	—	—	—	0	0
Apical depression	7	0 0	2 28.57	2 28.57 *	3 42.86%	—	—	—
Apical dots	7	0 0	2 28.57	5 71.43%	—	—	—	—
Flatness of fruit	7	0 0	0 0	3 42.86	3 42.86	1 14.29%	—	—
Smoothness of fruit	7	0 0	0 0	2 28.57	5 71.43	0 0%	—	—
Thinness of rind	7	0 0	3 42.36	4 57.14	0 0	0 0%	—	—
Thinness of segment wall	7	0 0	0 0	0 0	3 42.86	4 57.14%	—	—
Color of pulp	7	5 71.43	2 28.57	0 0	0 0	0 0%	—	—
Size of central column	7	0 0	1 14.29	2 28.57	2 28.57	2 28.57%	—	—
Quantity of pith	7	3 42.86	4 57.14	0 0	0 0	0 0%	—	—
Quality of pulp	7	2 28.57	5 71.43	0 0	0 0	0 0%	—	—

moderately sufficient amount of sugar to give a good taste. Although pulp vesicles are hardened, the flavor shows no deterioration. Pulp vesicles become free, due to dryness. The fruits are, at any rate, abnormal, but are not so inferior as they look.

The measurements of fruits are given in Table 152.\*

The crop of the same tree was again examined in the 1926-1927 season. 18 fruits were sent to the writer and they were described as follows :

Fruits large, grading to medium and a single small one (No. 10739). Rind rather hard and rough, more or less pitted, shiny, bright-colored without green spots; shape rather tall and conspicuous in its tendency to become conical; a few fruits have a projected base. Calyxes large, and in large fruit they are very large and flat, having a conspicuous double ring. In conical fruits, the basal end is sinuous, and some also show a distinct double ring. Calyx lobes are well developed. Apex generally simply flattened, seldom being concave. Dots around the stylar point vary from none to many as in some fruit (No. 10739) they are quite absent. Navel present or lacking. Good looking fruits though lacking uniformity of shape and size, and being abnormally rough.

In cross-section, the rind is thick, becoming puffy in the larger ones, oil cells large and irregular in one row. Central column rather small; abundant pith often penetrating the space between segments. Segments quite irregular in size and shape, corners rounded, inner ends obtuse, wall more or less thick and adherent. Pulp rather hard, deep-colored, coarse grained, becoming dry and discolored in large fruits; quality good, tasting normal, sweet, especially so in the large ones. Vesiculation distinct, netting more or less long, somewhat whitened, later becoming insipid. No deterioration of flavor is detected, even when the fruit is kept until Jan. 23, or even in thick-rind fruits. It seems fitted to keep longer than the average Wase.

The measurements of fruits are given in Table 153.\*\*

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\* PL. XXXIII, Fig. 2.

\*\* PL. XXXIII, Fig. 3.

TABLE 153.

MEASUREMENT OF 18 FRUITS (NOS. 10722-10739) FROM SECOND GENERATION  
TREE OF THE NAGATA WASE IN NAGATA'S ORCHARD, SHIDZUOKA  
PREFECTURE. LOT NO. 187 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.91 cm.	5.65 cm.	1.23	196.28 gm.	11.94 mm.	10.33	3.18 mm.	11.39 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	18	—	—	—	—	—	4	22.22%
Sinuate based fruits	18	—	—	—	—	—	8	44.44
Semi-sinuate based fruits	18	—	—	—	—	—	0	0
Areolated fruits	18	—	—	—	—	—	6	33.33
Frs. with undeveloped calyx lobes	18	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	18	—	—	—	—	—	1	5.56
Fruits containing seeds	18	—	—	—	—	—	1	5.56
Apical depression	18	0 0	0 0	12 66.67	6 33.33%	—	—	—
Apical dots	18	4 22.22	10 55.56	4 22.22%	—	—	—	—
Flatness of fruit	18	0 0	0 0	2 11.11	10 55.56	6 33.33%	—	—
Smoothness of fruit	18	1 5.56	9 50.00	5 27.78	3 16.67	0 0%	—	—
Thinness of rind	18	4 22.22	5 27.78	7 38.89	2 11.11	0 0%	—	—
Thinness of segment wall	18	3 16.67	10 55.56	2 11.11	3 16.67	0 0%	—	—
Color of pulp	18	14 77.78	4 22.22	0 0	0 0	0 0%	—	—
Size of central column	18	0 0	0 0	2 11.11	11 61.11	5 27.78%	—	—
Quantity of pith	18	1 5.56	6 33.33	11 61.11	0 0	0 0%	—	—
Quality of pulp	18	15 83.33	3 16.67	0 0	0 0	0 0%	—	—

The character of these coarse looking, large-sized fruits studied in successive years give us an understanding of the value of this particular Wase strain. The average Wase fruit has too thin a rind and is very poor for shipping and for keeping so it is desirable to eliminate such characters. The coarse rind of these NAGATA Wase fruits from top-worked trees may not be normal, however it must be remembered that this tendency is an unquestionable characteristic. No thickening of the rind was ever noticed in such thin-rind strains as Shintani Wase and Sueoka Wase.

### FRUITS FROM THE NORMAL BRANCH OF NAGATA'S BUD VARIATION TREE

In 1925, seven fruits from the normal branch of the original sport tree were sent by Mr. MATSUI. This was the first time that these fruits became accessible, due to the bad condition of the tree which gave no crop until this time. As stated before, the writer saw a last year's sprout from the normal part of NAGATA'S original tree in the spring of that year. These fruits sufficiently proved that at least they are not Wase, though they were all abnormal, small, roundish, green, and much pitted, and were probably picked before full maturity. The description of the fruit is as follows:

Fruits small, tall, apex only slightly depressed, dots generally reaching to the styler end; navel not developed, areola none. Base quite rounded, with low shoulder, somewhat conical at the base; stem end sinuous, grooves not developed, rarely with a distinct double ring (in No. 10269), sometimes with fine striations. Calyx small, well lobed, neither tall nor flat. Surface shallowly pitted, oil cell dots inconspicuous, fine and close. Outline regular; surface greenish, partly turning yellow, considerably late in maturing as compared with the Wase fruit picked at the same time. The yellow part is ochre, nor orange, and is quite unattractive. The disk-ring is not enlarged, with the single exception of No. 10269. Compact and heavy. (Nov. 28, 1925.)

The cross-section: Rind uniformly thick, oil cells forming a layer about one-third of the total thickness of the rind. Pith of the rind is

TABLE 154.

MEASUREMENT OF 7 FRUITS (NOS. 10269-10275) FROM NORMAL PART OF  
NAGATA'S BUD VARIATION TREE (NAGATA WASE) AT MIKKABI,  
SHIDZUOKA PREFECTURE. LOT NO. 165 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.20 cm.	4.64 cm.	1.25	78.59 gm.	10.86 mm.	10.29	2.93 mm.	9.07 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	7	—	—	—	—	—	0	% 0.0
Sinuate based fruits	7	—	—	—	—	—	7	100.0
Semi-sinuate based fruits	7	—	—	—	—	—	0	0
Areolated fruits	7	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	7	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	7	—	—	—	—	—	0	0
Fruits containing seeds	7	—	—	—	—	—	0	0
Apical depression	7	0 0	0 0	5 71.43	2 28.57%	—	—	—
Apical dots	7	0 0	4 57.14	3 42.86%	—	—	—	—
Flatness of fruit	7	0 0	0 0	2 28.57	4 57.14	1 14.29%	—	—
Smoothness of fruit	7	0 0	0 0	7 100.00	0 0	0 0%	—	—
Thinness of rind	7	0 0	0 0	2 28.57	4 57.14	1 14.29%	—	—
Thinness of segment wall	7	6 85.71	1 14.29	0 0	0 0	0 0%	—	—
Color of pulp	7	2 28.57	5 71.43	0 0	0 0	0 0%	—	—
Size of central column	7	0 0	0 0	3 42.86	1 14.29	3 42.86%	—	—
Quantity of pith	7	0 0	0 0	7 100.00	0 0	0 0%	—	—
Quality of pulp	7	5 71.43	2 28.57	0 0	0 0	0 0%	—	—

rather dense and white; oil cells small, close, fairly distinct and their distribution is regular. Central column small, quantity of pith not abundant, rather little; white pith not invading the space between the segment wall. Pulp fairly good in quality, melting, sweetish enough and not acidulous, fine-grained; the vesiculation is almost invisible. Color of pulp rather light.

Judging from these characters of the fruit, this looks more like an Ikeda than an Owari. According to the former information of Prof. ONDA and Mr. K. HARA, who visited the original tree in 1922, the normal part of the tree was identified as Owari, and the writer's second report (172) confirmed it. It is still questionable whether or not such characters of the fruits, as described above, were brought about by the abnormal condition of the tree. The writer already noticed in 1923 that the fruits on the neighboring trees were considerably round, notwithstanding the fact that they came from Owari province, where the Owari variety predominates over any other. A more definite statement will be made after receiving better material from a plant propagated from the normal part of the bud variation tree.

The measurements of these fruits are given in Table 154.\*

### **YAMADA WASE, THE SECOND BUD VARIATION STRAIN FOUND AT MIKKABI**

At the time when the author first made an attentive study of Mr. NAGATA's bud variation tree, his intelligent wife informed the writer that she knew a similar plant in a near-by orchard belonging to Mr. Masajirô YAMADA, to which she guided the writer in order for him to make an actual investigation. The tree looked to be in a fair condition, being much better than NAGATA's Wase plant, as it appeared to be more vigorous and was treated better. The following note was taken in 1923 when the plant was first visited.

The tree is about 20 years old, with a single trunk and four leading branches, one of which is unquestionable Wase. This branch presses an-

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\* PL. XXXIII, Fig. 4.

other branch hard at one spot in a crosswise direction and at the point of contact is more or less injured. The tree is about 1.3 m. high, and the sport branch is located at the south-west side of the tree, arising at about 30 cm. from the ground. The leaves of the Wase branch are characteristically crowded, smaller, twisted, and embrace a large bud at the bottom. This tree was previously owned by Sadajirô TOMIYAMA, and it is said that he found the variation in 1919.

The tree was re-examined in both 1925 and 1926. The leaves of the normal part are not hanging, they are generally upright and boat-shaped and the branches are abundant.

In the first year (1923), only two fruits were available from the variation branch, and in the second year (1924) 12 fruits were picked. The descriptions of these fruits are given below :

(1) 1923. Two fruits (Nos. 7364-7365). The first is a tall, round fruit of 20.9 cm. in girth and 5.7 cm. high, with a distinct double ring and an enlarged disk, both ends being only shallowly concave. Calyx large, normal, 11 mm. in diameter. Navel closed, no areola, and dots reach to the styler point. The whole fruit weighs 134 gm. Cross-section looks like Wase: Rind 2-3 mm., thin, segment wall also thin, central 12×9 mm. across, medium-small-sized, containing medium quantity of pith. Segments 10. Pulp deep-colored, beautiful looking, coarse-grained, fully mature, good tasting.

The second fruit is smaller, 18.2 cm. in girth, 4.7 cm. in height and weighs 86 gm. End more or less flattened, color greenish, lacks double ring. Calyx is large, disk enlarged. Navel and areola, both lacking. Section has 10 segments, rind thin, 1-2 mm., central column medium-small, 12.6 mm. across, with medium amount of pith. Pulp deep-colored and tastes good.

Both contain no seed and these characters agree with Wase.

(2) 1924. 12 fruits (Nos. 9171-9182). Fruit also Wase-like, varying from large to medium, without small ones. Shape tall, rectangular, rarely pointed at the base, surface even, oil cell dots very large and convex, very prominent, bright-colored with a few greenish

TABLE 155.

MEASUREMENT OF 12 WASE FRUITS (NOS. 9171-9182) OF YAMADA'S BUD  
VARIATION TREE AT MIKKABI, INASA-GUN, SHIDZUOKA-KEN,  
STUDIED IN 1924 (LOT NO. 140)

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.32 cm.	5.32 cm.	1.28	130.08 gm.	11.75 mm.	9.75	2.73 mm.	11.92 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	12	—	—	—	—	—	0	% 0
Sinuate based fruits	12	—	—	—	—	—	7	58.33
Semi-sinuate based fruits	12	—	—	—	—	—	0	0
Areolated fruits	12	—	—	—	—	—	7	58.33
Frs. with undeveloped calyx lobes	12	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	12	—	—	—	—	—	1	8.33
Fruits containing seeds	12	—	—	—	—	—	0	0
Apical depression	12	0 0	0 0	4 33.33	8 66.67%	—	—	—
Apical dots	12	2 16.67	3 25.00	7 58.33%	—	—	—	—
Flatness of fruit	12	0 0	0 0	5 41.67	3 25.00	4 33.33%	—	—
Smoothness of fruit	12	1 8.33	9 75.00	2 16.67	0 0	0 0%	—	—
Thinness of rind	12	6 50.00	3 25.00	3 25.00	0 0	0 0%	—	—
Thinness of segment wall	12	0 0	2 16.67	4 33.33	3 25.00	3 25.00%	—	—
Color of pulp	12	7 58.33	5 41.67	0 0	0 0	0 0%	—	—
Size of central column	12	0 0	1 8.33	8 66.67	3 25.00	0 0%	—	—
Quantity of pith	12	6 50.00	4 33.33	2 16.67	0 0	0 0%	—	—
Quality of pulp	12	1 8.33	2 16.67	6 50.00	3 25.00	0 0%	—	—



patches. Apex rounded, rarely depressed, areola exists but is not prominent; navels all closed. Mostly with sinuate stem-end, but often the base is flattened. Calyx fairly large and lobes rarely elongated. Disk large but not extremely enlarged. There are a few fruits with basal double ring, but fine radial striations are not pronounced. Many sharp furrows radiate in some conical fruits.

The cross-section is poor looking, the degenerating appearance of the fruit is clear. Rind varying from medium-thin to medium with large dispersed oil cells, and solid, white inner layer. The central column from medium to medium-small, rarely medium-large, with an enormous amount of pith and conspicuous fiber strands. Segment wall very thick. Segments irregular in shape, corner much rounded, margin often emarginate, inner end quite rounded. Pulp juicy, either deep or medium-deep-colored, coarsely grained, taste poor, some distinctly bitter, and only rarely good. Unquestionably the tree is deteriorating. Pulp vesicles distinct, usually not separable.

The measurements of these fruits are given in Table 155.\*

Fruits were not sent in the following years, possibly due to the poor condition of tree, which was already noticed in the condition of the fruit as given above. This Wase seems to be poor and ranks very close to the Hozaki Wase. Morphologically it may come under the same category as Miyagawa Wase and Mikami Wase.

### NORMAL PART OF YAMADA'S BUD VARIATION TREE

The crop of the normal part of YAMADA'S bud variation tree was inspected in 1924. Notes taken at that time are as follows:

Fruits small, tall, shape rectangular, shoulder high. Both ends less depressed, base has no groove, stem-end sinuous. Texture of rind is rough and pitted. Calyx large. Navel rather conspicuous, especially in large-sized fruits.

Segments rather many; rind thick, tight, not puffy, leathery, durable. Pulp conspicuously inferior, taste poor, fibrous and coarse, though

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\* PL. XXXIV, Fig. 2.

TABLE 156.

MEASUREMRNT OF 35 FRUITS (NOS. 7602-7636) FROM NORMAL PART OF  
YAMADA'S BUD VARIATION TREE AT MIKKABI, SHIDZUOKA  
PREFECTURE. LOT NO. 107 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.49 cm.	4.43 cm.	1.33	85.54 gm.	9.82 mm.	10.70	2.65 mm.	9.81 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	33	—	—	—	—	—	13	39.39
Sinuate based fruits	33	—	—	—	—	—	26	78.79
Semi-sinuate based fruits	33	—	—	—	—	—	0	0
Areolated fruits	33	—	—	—	—	—	1	3.03
Frs. with undeveloped calyx lobes	33	—	—	—	—	—	2	6.06
Frs. with long narrow calyx lobes	33	—	—	—	—	—	1	3.03
Fruits containing seeds	13	—	—	—	—	—	1	7.69
Apical depression	33	2 6.06	11 33.33	16 48.48	4 12.12%	—	—	—
Apical dots	33	1 3.03	4 12.12	23 84.85%	—	—	—	—
Flatness of fruit	33	3 9.09	12 36.36	12 36.36	6 18.18	0 0%	—	—
Smoothness of fruit	33	1 3.03	5 15.15	27 81.82	0 0	0 0%	—	—
Thinness of rind	13	5 38.46	8 61.54	0 0	0 0	0 0%	—	—
Thinness of segment wall	13	7 53.85	6 61.54	0 0	0 0	0 0%	—	—
Color of pulp	13	10 76.92	3 23.08	0 0	0 0	0 0%	—	—
Size of central column	13	0 0	0 0	4 30.77	4 30.77	5 38.46%	—	—
Quantity of pith	13	0 0	0 0	13 100.00	0 0	0 0%	—	—
Quality of pulp	11	3 27.27	4 36.36	4 36.36	0 0	0 0%	—	—

juice is abundant. Segment wall thick, central column small. Seeds rarely present.

Measurements of fruits are given in Table 156.\*

From these observations, the tree was identified as most likely Zairai, a rather unusual occurrence in this territory. The origin of this tree is unknown because of the change of ownership. The bud presumably came from the old planting near Okabe in the same prefecture.

### SHIMIDZU WASE, ANOTHER NEW BUD VARIATION WASE FOUND IN 1923

After observing the method of the writer's investigation of bud variation trees for the first time at Mikkabi in Shidzuoka Prefecture, Mr. Ken'itsu MATSUI, who assisted the former in the field, raised the question as to whether a plant he had seen a month ago would be a case of similar variation. Under the guidance of Mr. MATSUI, the writer visited a planting belonging to Mr. Kōichi SHIMIDZU, at Fukunaga of the same village, and immediately found the plant, which was sought (PL. LII, Fig. 1, 2, and 2\*). The orchard is on a moderate slope facing to the east, and the tree is on the third plot (from the south), being the second plant from the south, on the fifth row from the east. The trees of the orchard are planted at a distance of  $4.4 \times 3.5$  m., and the plant under observation has a spread of 2 m. in both N-S and E-W directions, and a height of 1.7 m. The whole plant is a vigorous Ōwari of good shape with characteristic dispersed foliage on spreading branches. The variation branch is well characterized by having extremely large and early coloring fruits, but the branch bearing these fruits does not look very different because the leaves on it are well-colored and normal, only being slightly more crowded. The variation branch is on the north-eastern side of the tree, rising from a point about 58 cm. from the ground and growing to be about 1 m. long; it is probably about 5 years old. The tree was visited by Mr. MATSUI and Mr. NAGANO of the Growers' Association, on 23rd. of October in 1923, and they saw the abnormal

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\* PL. XXXIV, Fig. 3.

early coloring of the fruit on this particular branch, although they did not know that this was a case of bud variation. The soil is reddish clay with angular pebbles. The treatment of the plant was not mentioned.

The entire crop of the variation branch was later sent for a detailed study (see Table 157).

Re-observation of the tree in 1925 showed that the surface of the tree has a considerably large uneven area on the big branch from which the variation limb arises. The leaves on the variation branch are very much crowded and show typical contortion. The leaves on the other branches are larger, the condition of the shoots being decidedly more vigorous. The whole tree looked to be rather uncared for and remained unpruned. The crop of the preceding year (1924) was small and rather poor, but that of the next year (1925) showed some improvement.

In 1926, the tree was pruned very severely, and naturally the following crop was very poor. In this year, the leaves on the normal part were upright, boat-shaped, rather crowded, deep green, vigorous and healthy. The variation branch bore leaves a little more crowded; they were rather large, short, lozenge-shaped, and typical of Wase. Only 11 fruits were collected in this year.

The crop harvested in 1923 consisted of 67 fruits (Nos. 7366-7432), the description of which is given below :

Fruit ranging from round to flat : shape more or less rectangular as in ordinary Wase, but many of them are flattened and of better shape. Average size is medium-large. Apex not much depressed, naval not developing, areola also inconspicuous, Base broadly concave, shallow, no sign of sinuation at the calyx-end. Fine striations present at this end. Calyx large, disk not enlarged. Surface very smooth, good-colored, skin delicate in texture, easily shrivels; oil cell dots extremely large and very conspicuous, all being convex, none forming fovea. Skin tight, easily softened but never becoming puffy.

Cross-section has a thin rind. Segment wall rather thick, sometimes very thick and somewhat adherent. Central column small, pith usually

TABLE 157.

MEASUREMENT OF 67 WASE FRUITS (NOS. 7366-7432) FROM SHIMIDZU'S  
BUD VARIATION TREE AT MIKKABI, SHIDZUOKA PREFECTURE.  
LOT NO. 104 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.79 cm.	4.47 cm.	1.34	88.24 gm.	9.80 mm.	9.40	2.19 mm.	10.72 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	67	—	—	—	—	—	0	% 0
Sinuate based fruits	67	—	—	—	—	—	0	0
Semi-sinuate based fruits	67	—	—	—	—	—	0	0
Areolated fruits	66	—	—	—	—	—	3	4.55
Frs. with undeveloped calyx lobes	66	—	—	—	—	—	1	1.52
Frs. with long narrow calyx lobes	66	—	—	—	—	—	0	0
Fruits containing seeds	65	—	—	—	—	—	0	0
Apical depression	66	5 7.58	43 65.15	18 27.27	0 0%	—	—	—
Apical dots	66	5 7.58	36 54.55	25 37.38%	—	—	—	—
Flatness of fruit	67	10 14.93	21 31.34	29 43.28	7 10.45	0 0%	—	—
Smoothness of fruit	67	20 29.85	47 70.15	0 0	0 0	0 0%	—	—
Thinness of rind	65	62 95.38	3 4.62	0 0	0 0	0 0%	—	—
Thinness of segment wall	65	16 24.62	33 50.77	16 24.62	0 0	0 0%	—	—
Color of pulp	65	53 81.54	12 18.46	0 0	0 0	0 0%	—	—
Size of central column	65	0 0	0 0	32 49.23	27 41.54	6 9.23%	—	—
Quantity of pith	64	1 1.56	35 54.69	28 43.75	0 0	0 0%	—	—
Quality of pulp	62	53 85.48	5 8.06	3 4.84	1 1.61	0 0%	—	—

much. Pulp deep-colored, very coarse-grained, but not meaty and hard, usually very juicy and often melting, frequently of very good quality, average better than the ordinary Aoe Wase fruits.

Keeping quality is rather poor, the fruit soon developing a decay by being affected by blue mould and gray mould (*Penicillium*, *Botrytis*, etc.).

The measurements of these fruits are given in Table 157.\*

Four fruits (Nos. 9157-9160) harvested in 1924 are described below.

Size ranging from large to medium, typically flat, slightly conical, polished (glazed), with very large oil cell dots, bright-colored, partly greenish. The first two fruits have the typical size and shape of Wase, with very much enlarged disks and double rings. Apex merely flat, not concave, navel wanting, areola exists only in one fruit. Dots sometimes absent around the stylar point. Base broadly sinuous in No. 9159 and deeply ringed-sinuate in No. 9160. Calyx normal. The Wase characters are distinct.

The cross-section: The rind rather thin, brittle, central column medium or more or less small, with thick, compact pith which extends toward the space between the segment walls, making them appear thick. Pulp not deep-colored, coarsely grained, more or less raggy, but not dry; juicy, good quality in the first fruit but the rest are medium grade in quality, being somewhat bitterish. Pulp vesicles distinctly large, elongated reticulate, demarcation of which is clear. Oil cells of the rind are large but not very close.

The average figures of these four fruits measured are given in Table 158.\*\*

The following description is given after examining 94 fruits (Nos. 10372-10465) of the Shimidzu Wase in 1925.

Fruits medium to large in size, the tree having borne heavily, the first (largest) fruit not too large, grading slowly toward the minor groups, quite uniform in range. Shape comparatively flat, a very desirable shape, rather non-uniform in outline with irregularly large segments swelling

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\* PL. XXXIV, Fig. 4.

\*\* PL. XXXIV, Fig. 5.

TABLE 158,

MEASUREMENT OF 4 FRUITS (NOS. 9157-9160) OF THE SHIMIDZU WASE  
SATSUMA FROM MIKKABI, SHIDZUOKA PREFECTURE.

LOT NO. 137 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
23.70 cm.	5.45 cm.	1.39	169.50 gm.	12.25 mm.	9.50	2.76 mm.	15.25 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	4	—	—	—	—	—	0	% 0
Sinuate based fruits	4	—	—	—	—	—	0	0
Semi-sinuate based fruits	4	—	—	—	—	—	0	0
Areolated fruits	4	—	—	—	—	—	2	50.0
Frs. with undeveloped calyx lobes	4	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	4	—	—	—	—	—	0	0
Fruits containing seeds	4	—	—	—	—	—	0	0
Apical depression	4	0 0	0 0	3 75.00	1 25.00%	—	—	—
Apical dots	4	1 25.00	2 50.00	1 25.00%	—	—	—	—
Flatness of fruit	4	1 25.00	1 25.00	2 50.00	0 0	0 0%	—	—
Smoothness of fruit	4	0 0	4 100.00	0 0	0 0	0 0%	—	—
Thinness of rind	4	1 25.00	3 75.00	0 0	0 0	0 0%	—	—
Thinness of segment wall	4	0 0	0 0	0 0	2 50.00	2 50.00%	—	—
Color of pulp	4	2 50.00	2 50.00	0 0	0 0	0 0%	—	—
Size of central column	4	0 0	0 0	3 75.00	1 25.00	0 0%	—	—
Quantity of pith	4	2 50.00	2 50.00	0 0	0 0	0 0%	—	—
Quality of pulp	4	1 25.00	0 0	3 75.00	0 0	0 0%	—	—

outward. Apex rather concave, oil cell dots generally present, but few around the stylar point, sometimes naked or rarely excavated rather suddenly from the areola region. Basal end flat, less concave, shoulder low and smooth. Calyx slightly concave, without radial grooves and fine radial striations not conspicuous, only exceptionally marked with a double ring. Calyx large, well developed, often with elongated lobes, rarely with undeveloped ones. Areola fairly well developed, but the navel development is rather poor. Surface bright-colored, but not very intense, smooth, early colored ones more or less pitted. Oil cell dots large, conspicuous, even or convex, some distinctly concave. Percentage of green fruits rather large.

A well established Wase with desirable flatness and a remarkably heavy bearing.

Cross-section: The rind is almost uniformly thin. Segments large, wall generally thin with a small percent of medium-thin ones, but generally not medium. Irregularity of the segment in size is somewhat pronounced. Central column rather large, quantity of pith is medium or slightly more than medium, never very abundant. Pulp deep-colored, slightly variable in quality, average sweet, but not intense. A few slightly acidulous or subacid members are mixed in generally of good quality; however, most of them are slightly over-ripe, and a few fallen fruits taste bitterish. Apparently the fruit reaches its full maturity while the rind is still green. The sweet taste is not strong, but the juice is abundant, although the feeling in the mouth is slightly crisp and meaty. Pulp vesicles most conspicuously coarse-netted, demarcation of which is very clear, often getting loose, but they never solidify. The quality is fair but not very good.

The measurements of these fruits are given in Table 159.\*

Eleven fruits (Nos. 10889-10899) were received in 1926, on which the following note was taken.

Fruits medium-sized, grading slowly, comparatively flat, but many conspicuously pear-shaped, mostly protruding abruptly at the end. Hori-

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\* PL. XXXV, Fig. 1.



TABLE 159.

MEASUREMENT OF 94 FRUITS (NOS. 10372-10465) OF THE SHIMIDZU WASE  
FROM MIKKABI, SHIDZUOKA PREFECTURE. LOT  
NO. 174 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.39 cm.	4.52 cm.	1.43	98.11 gm.	11.77 mm.	10.15	2.44 mm.	13.35 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	94	—	—	—	—	—	21	22.34%
Sinuate based fruits	94	—	—	—	—	—	0	0
Semi-sinuate based fruits	94	—	—	—	—	—	0	0
Areolated fruits	94	—	—	—	—	—	44	46.81
Frs. with undeveloped calyx lobes	94	—	—	—	—	—	8	8.51
Frs. with long narrow calyx lobes	94	—	—	—	—	—	10	10.64
Fruits containing seeds	94	—	—	—	—	—	0	0
Apical depression	94	7 7.45	37 39.36	45 47.87	5 5.32%	—	—	—
Apical dots	94	24 25.53	61 64.89	9 9.57%	—	—	—	—
Flatness of fruit	94	75 79.79	19 20.21	0 0	0 0	0 0%	—	—
Smoothness of fruit	94	22 23.40	58 61.70	14 14.89	0 0	0 0%	—	—
Thinness of rind	94	82 87.23	11 11.70	1 1.06	0 0	0 0%	—	—
Thinness of segment wall	94	42 44.68	52 55.32	0 0	0 0	0 0%	—	—
Color of pulp	94	88 93.62	6 6.38	0 0	0 0	0 0%	—	—
Size of central column	94	3 3.19	20 21.28	65 69.15	5 5.32	1 1.06%	—	—
Quantity of pith	94	0 0	34 36.17	60 63.83	0 0	0 0%	—	—
Quality of pulp	94	64 68.09	21 22.34	8 8.51	1 1.06	0 0%	—	—

zontal outline very irregular, due to the presence of a few abnormally large segments. Calyx large, almost normal, well lobed, disk generally large, sometimes with faint demarcation, but mostly strongly margined and conspicuously sinuous, rarely double ringed (No. 10890). Apex always nearly flat, only very slightly concave, naked area small, never conspicuous, areola sometimes present, navel not open. All well colored, very bright, some with conspicuously large oil cell dots, but some pear-shaped fruits are pitted. Size of oil cells fairly uniform. Owing to the small crop, the fruits are abnormal and *Alternaria* rot is frequent.

The cross-section of fruits: Segments irregular in shape and size, very rounded at the outer end. Rind medium-thin, rather uniform in thickness, texture strong, inner layer white and adherent to segments. Segments easily separable, wall thick and white, often being tightly fastened at the center with strong pith. Central column medium-sized, with abundant pith. Pulp often light-colored, flavor decidedly deteriorating, due to the abnormal condition of the tree, only a few are fairly good but the rest are acidulous, often being spoiled by rot and are not edible. Vesiculation clear, coarse, not hardened.

The measurements of these fruits are given in Table 160.\*

It can be concluded from this data obtained in succeeding years that, the quality of the fruit seems very variable, and the fruit readily shows deterioration when the condition of the tree is bad. It shows quite a good quality when the condition of the tree is fair, and the change is so great in off-years that the tree cannot be considered as of any value. The merit of this strain is, therefore, questionable until careful examination has been carried out on a large scale.

### CHARACTER OF FRUITS FROM THE NORMAL PART OF SHIMIDZU WASE

The crop picked in 1923 from the normal part of the bud variation tree owned by Kôichi SHIMIDZU, located at Fukunaga, Mikkabi, Shidzuoka

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\* PL. XXXV, Fig. 2.

TABLE 160.

MEASUREMENT OF 11 FRUITS (NOS. 10889-10899) OF THE SHIMIDZU WASE  
FROM MIKKABI, SHIDZUOKA PREFECTURE. LOT  
NO. 197 OF 1926.

Ax. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.19 cm.	4.99 cm.	1.28	101.09 gm.	11.36 mm.	10.00	2.68 mm.	11.36 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	11	—	—	—	—	—	0	% 0
Sinuate based fruits	11	—	—	—	—	—	0	0
Semi-sinuate based fruits	11	—	—	—	—	—	11	100.00
Areolated fruits	11	—	—	—	—	—	6	54.55
Frs. with undeveloped calyx lobes	11	—	—	—	—	—	1	9.09
Frs. with long narrow calyx lobes	11	—	—	—	—	—	0	0
Fruits containing seeds	11	—	—	—	—	—	0	0
Apical depression	11	0 0	0 0	6 54.55	5 45.45%	—	—	—
Apical dots	11	0 0	7 63.64	4 36.36%	—	—	—	—
Flatness of fruit	11	0 0	1 9.09	6 54.55	3 27.27	1 9.09%	—	—
Smoothness of fruit	11	0 0	8 72.73	3 27.27	0 0	0 0%	—	—
Thinness of rind	11	7 63.64	4 36.36	0 0	0 0	0 0%	—	—
Thinness of segment wall	11	0 0	3 27.27	7 63.64	1 9.09	0 0%	—	—
Color of pulp	11	0 0	10 90.91	1 9.09	0 0	0 0%	—	—
Size of central column	11	0 0	1 9.09	8 72.73	0 0	2 18.18%	—	—
Quantity of pith	11	4 36.36	4 36.36	3 27.27	0 0	0 0%	—	—
Quality of pulp	11	1 9.09	4 36.36	3 27.27	2 18.18	1 9.09%	—	—

Prefecture, showed that the tree is an Owari with rather small-sized fruits. The description given in 1923 is as follows:

Fruits rather small, flattened, base rather deeply depressed with grooves. Apex more or less deeply depressed, navel marking not conspicuous. Calyx well lobed but not large in size. Shoulder of the fruit is not high. Fruits later become rather puffy.

Cross-section: Number of segments not many, rind usually flexuous, thin, easily removed. Segment wall thin, pulp deep-colored, sweet, not inferior in quality. Central column medium-sized, pith little in quantity. Only rarely seedy.

This is very different from the fruit of the normal part of YAMADA's bud variation tree, although both have a similar size.

The measurements of fruits are given in Table 161.\*

The crop of the normal part of SHIMIDZU's bud variation tree was re-examined in 1924, an account of which is given in the following:

Fruits medium-sized, not at all small, outline more or less irregular, rather compact and heavy. Shape flat to medium-flat; apex simply flattened, only slightly concave, navel closed, dotless area around the stylar point is almost none. Areola not seen. Base shallowly but distinctly concave, only short grooves, radiating striations, as seen in Wase fruit, do not exist; disk small, not visible from the outside, being covered by the calyx body. Lobes of calyx rarely elongated. Tight-skinned, and the surface is pitted, light-colored, with green patches; oil cell dots rather large, close, and generally convex.

The cross-section of the fruit approaches the Wase borne on the same tree in the small number of segments, medium-sized central column, abundant quantity of pith, and thick wall. Oil cells of the rind are also large, but are close, the size being almost the same. Pulp not intensely colored, tasting acibulous and not sweet, with a very slight bitterness. Vesicles decidedly smaller than those of the Wase fruit and more elongated. Segment wall is also slightly thinner than that of the Wase fruit.

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\* PL. XXXV, Fig. 3.

TABLE 161.

MEASUREMENT OF 42 OWARI FRUITS (NOS. 7560-7601) FROM THE NORMAL PART OF SHIMIDZU'S BUD VARIATION TREE IN MIKKABI, SHIDZUOKA-KEN. LOT NO. 105 (1923).

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.38 cm.	4.10 cm.	1.43	74.62 gm.	10.05 mm.	9.57	2.86 mm.	10.74 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	40	—	—	—	—	—	4	10.00
Sinuate based fruits	40	—	—	—	—	—	6	15.00
Semi-sinuate based fruits	40	—	—	—	—	—	14	35.00
Areolated fruits	40	—	—	—	—	—	20	50.00
Frs. with undeveloped calyx lobes	40	—	—	—	—	—	7	17.50
Frs. with long narrow calyx lobes	40	—	—	—	—	—	0	0
Fruit containing seeds	40	—	—	—	—	—	1	4.76
Apical depression	40	6 15.00	19 47.50	15 37.50	0 0%	—	—	—
Apical dots	40	1 2.50	15 37.50	24 60.00%	—	—	—	—
Flatness of fruit	40	23 57.50	16 40.00	0 0	1 2.50	0 0%	—	—
Smoothness of fruit	40	9 22.50	25 62.50	6 15.00	0 0	0 0%	—	—
Thinness of rind	21	8 38.10	8 38.10	5 23.81	0 0	0 0%	—	—
Thinness of segment wall	21	21 100.00	0 0	0 0	0 0	0 0%	—	—
Color of pulp	21	12 57.14	8 38.10	1 4.76	0 0	0 0%	—	—
Size of central column	21	0 0	1 4.76	13 61.90	7 33.33	0 0%	—	—
Quantity of pith	21	0 0	0 0	17 80.75	4 19.05	0 0%	—	—
Quality of pulp	18	10 55.56	7 38.89	1 5.56	0 0	0 0%	—	—

TABLE 162.

MEASUREMENT OF 5 OWARI FRUITS (NOS. 9161-9165) FROM SHIMIDZU'S  
BUD VARIATION TREE AT MIKKABI, SHIDZUOKA PREFECTURE.  
LOT NO. 138 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.46 cm.	4.80 cm.	1.42	116.20 gm.	10.80 mm.	9.40	3.05 mm.	13.40 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	5	—	—	—	—	—	0	% 0
Sinuate based fruits	5	—	—	—	—	—	0	0
Semi-sinuate based fruits	5	—	—	—	—	—	0	0
Areolated fruits	5	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	5	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	5	—	—	—	—	—	0	0
Fruits containing seeds	5	—	—	—	—	—	0	0
Apical depression	5	0 0	0 0	5 100.00	0 0%	—	—	—
Apical dots	5	0 0	0 0	5 100.00%	—	—	—	—
Flatness of fruit	5	5 100.00	0 0	0 0	0 0	0 0%	—	—
Smoothness of fruit	5	0 0	3 60.00	2 40.00	0 0	0 0%	—	—
Thinness of rind	5	0 0	4 80.00	1 20.00	0 0	0 0%	—	—
Thinness of segment wall	5	0 0	2 40.00	1 20.00	2 40.00	0 0%	—	—
Color of pulp	5	0 0	4 80.00	1 20.00	0 0	0 0%	—	—
Size of central column	5	0 0	0 0	5 100.00	0 0	0 0%	—	—
Quantity of pith	5	2 40.00	3 60.00	0 0	0 0	0 0%	—	—
Quality of pulp	5	0 0	2 40.00	3 60.00	0 0	0 0%	—	—

TABLE 163.

MEASUREMENT OF 11 OWARI FRUITS (NOS. 10466-10476) FROM SHIMIDZU'S  
BUD VARIATION TREE AT MIKKABI, SHIDZUOKA  
PREFECTURE. LOT NO. 175 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.79 cm.	4.15 cm.	1.40	75.82 gm.	11.45 mm.	10.27	3.07 mm.	11.59 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	11	—	—	—	—	—	1	% 9.09
Sinuate based	11	—	—	—	—	—	0	0
Semi-sinuate based fruits	11	—	—	—	—	—	0	0
Areolated fruits	11	—	—	—	—	—	9	81.82
Frs. with undeveloped calyx lobes	11	—	—	—	—	—	1	9.09
Frs. with long narrow calyx lobes	11	—	—	—	—	—	1	9.09
Fruits containing seeds	11	—	—	—	—	—	0	0
Apical depression	11	<sup>3</sup> 27.27	<sup>5</sup> 45.45	<sup>2</sup> 18.18	<sup>1</sup> 9.59%	—	—	—
Apical dots	11	<sup>0</sup> 0	<sup>5</sup> 45.45	<sup>6</sup> 54.55%	—	—	—	—
Flatness of fruit	11	<sup>8</sup> 72.73	<sup>2</sup> 18.18	<sup>1</sup> 9.09	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Smoothness of fruit	11	<sup>0</sup> 0	<sup>2</sup> 18.18	<sup>6</sup> 54.55	<sup>3</sup> 27.27	<sup>0</sup> 0%	—	—
Thinness of rind	11	<sup>0</sup> 0	<sup>2</sup> 18.18	<sup>7</sup> 63.64	<sup>2</sup> 18.18	<sup>0</sup> 0%	—	—
Thinness of segment wall	11	<sup>6</sup> 54.55	<sup>5</sup> 45.45	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Color of pulp	11	<sup>8</sup> 72.73	<sup>3</sup> 27.27	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Size of central column	11	<sup>0</sup> 0	<sup>0</sup> 0*	<sup>8</sup> 72.73	<sup>3</sup> 27.27	<sup>0</sup> 0%	—	—
Quantity of pith	11	<sup>0</sup> 0	<sup>3</sup> 27.27	<sup>8</sup> 72.73	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Quality of pulp	11	<sup>0</sup> 0	<sup>6</sup> 54.55	<sup>5</sup> 45.45	<sup>0</sup> 0	<sup>0</sup> 0%	—	—

Like the Wase fruits of this year, these examples are not normal, due to the bad condition of the tree.

The measurements of the fruits are given in Table 162.\*

A crop of the same Owari fruit from the normal branches of SHIMIDZU's bud variation tree was again studied in 1925. The description is given below:

Fruits large, grading toward moderately small-size, flat, bright-colored, with the typical Owari pitting and great apical depression. The horizontal outline is rather irregular, flatness is pronounced in most of them, the shoulder is high. Apex broadly deep-depressed with distinct areola, dots reaching to the styler point, navel present in exceptional cases. In some fruit (Nos. 10470, 10472), the depression of the apex is very pronounced, sometimes being sinuous (No. 10476). In deeply depressed fruits, the areola is very conspicuous, forming a sharp, pitted double ring. Base flat, calyx end rather deeply concave and more or less grooved. Calyx normal, large-sized, lobes being well developed; disk not enlarged.

Cross-section; Rind rather thick, inner layer rather porous, raggy, oil cells rather large and distinct; the horizontal outline is rather wavy. Segments few, wall moderately thin, soft and wavy. Central column medium-sized, pith medium in quantity or slightly more than medium. Pulp fine-grained, but vesiculation visible, fairly juicy and acidulous, not so sweet as it looks (fertilization insufficient). Largest fruits have a better color in the pulp and a good flavor, and are rather large-grained, although the fruits of Wase coming from the same tree are more mature.

The measurements of the fruit given above are in Table 163.\*\*

Judging from the observations made in three succeeding years, the plant seems to be an Owari of poor quality. The variation of the shape and size of the fruit annually is rather great, so that it is unquestionably an inferior strain of Owari.

### **TAKAHASHI WASE FROM KANAGAWA PREFECTURE**

The author's attention was called by Mr. Tsuneji TOGASHI of the Kanagawa Agricultural Experiment Station, to a bud sport Wase in an

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\* PL. XXXV, Fig. 4.

\*\* PL. XXXVI, Fig. 1.



orchard at Kawamura, near Yamakita on the Tōkaidō railway route. The exact location of the tree is in the orchard of Byōnosuke TAKAHASHI at Maruyama, Kawamuragishi, Kawamura, Ashigara-kamigun, Kanagawa-ken, and the tree was visited by the author on Nov. 3, 1923. The plant is found on a slight slope lowering toward the west, being the second tree in the N-W row (northernmost row) facing the adjacent orchard of Mr. KOSUGI. The orchard is full of large-sized Satsuma trees of a similar age, slightly less than 30 years, planted fairly regularly at distance of 4.4 m. apart. This particular plant has a diameter of 4 m. in E-W spread, 4.4 m. in N-S spread, and a height of 3 m. (PL. LII, Fig. 3, 3<sup>a</sup>, 4, and 5). It is a wide spreading tree with loose center and a few major branches coming out from a very short common trunk. The side branches are often drooping, the leaves large, sharp-pointed and dark-colored. The branch indicated to be the sport limb is on the N-W side of the tree, coming out at a point 1.4 m. vertical from the ground, and 1.5 m. from the bottom of the trunk measured along its course. The branch shows almost no appreciable difference from the other branches of the same tree except that a few uneven marks are found on the lowermost part of the branch, a sign occasionally found in a bud variation or reversion limb. The leaves on this branch are dense, on rather straight shoots, not short-noded nor zigzag. The leaf blade is long, not lozenge-shaped nor twisted, but is slightly lighter in color than the other part of the tree. The soil is not fertile, being covered by volcanic ash, and is black sandy loam with small pebbles. Fertilization is normal, fish cake and super-phosphate of ammonia being used; not mulched. The tree was propagated by Kurajirō TAKAHASHI, father of the present owner, scions being taken from a plant propagated in 1888. The latter was originally grafted upon trifoliate root-stock introduced from the Angyō nurseries of Saitama Prefecture. The source of the scion was manifold, partly from Wakayama Prefecture, Kataura region of Kanagawa Prefecture, or from local Satsuma plants. The early coloring of the fruits on this branch was first noticed about 10 years before this time, and the fruit was occasionally displayed at local fairs, winning prizes. A few young plants propagated from this branch retain the character of the

original branch, according to the information given by Mr. TAKAHASHI's son. They bear leaves which are not so long, not so pointed, and not so deep-colored as the ordinary Owari Satsumas. This year (1923) was favored with a big crop of 97 fruits, and it is said that the size of the fruits is considerably small on that account. The entire crop of this branch and that of a normal branch were studied (for comparison). The early maturing fruits picked on Nov. 3, are described below :

Fruits medium-small, ranging from medium-large to small, outline oblate-obovoid, more or less rounded at the base, and a trifle more round than the fruits from the other branches; usually equi-dorsiventral and taller than they look. The apical depression is rather prominent, while the base is only slightly concave. Navel mark prominent, especially in larger fruits. Calyx medium in size, lobes rather thin and many undeveloped ones occur, easily shrivel. Disk is concealed underneath, its margin is not enlarged, only exceptionally flattened and developing a double ring. Sinuation around the calyx is often seen, but later it disappears and the area becomes flat. Surface more or less rough, pitted, not so smooth as in the average Wase fruits of other strains, but later in the season it seems to become smoother. Areola present in many fruits. The rind is tight, well-colored at the apex, and partly green on the sides; the color is not very bright. Infection of sooty mould and melanose rust is occasionally seen.

The cross-section has normal thickness of rind (from thin to medium-thin), normal size of central column (generally from medium to medium-small), and normal amount of pith (medium grade). The wall is thin. Pulp is conspicuously coarse-grained, typical of Wase, meaty; advanced maturity is pronounced, of very good quality and palatable. Although the fruit lacks certain Wase characters in several points, the character of the pulp vesicles is decidedly Wase, such as can never be seen in any other variety of the Owari group.

This bud variant was first called Takahashi Han-Wase (semi-praecox) due to the lack of certain Wase characters, but the name was later reduced to simple "Wase", after repeated examination of the fruits in following years proved it to be a definite Wase.

TABLE 164.

MEASUREMENT OF 97 WASE FRUITS (NOS. 7060-7156) FROM TAKAHASHI'S  
BUD VARIATION TREE, AT KAWAMURA, KANAGAWA  
PREFECTURE. LOT NO. 96 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.89 cm.	4.07 cm.	1.32	61.78 gm.	10.08 mm.	10.48	2.46 mm.	9.66 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	97	—	—	—	—	—	39	40.21%
Sinuate based fruits	97	—	—	—	—	—	7	7.22
Semi-sinuate based fruits	97	—	—	—	—	—	14	14.43
Areolated fruits	97	—	—	—	—	—	42	43.30
Frs. with undeveloped calyx lobes	96	—	—	—	—	—	22	22.92
Frs. with long narrow calyx lobes	96	—	—	—	—	—	0	0
Fruits containing seeds	96	—	—	—	—	—	1	1.04
Apical depression	97	18 18.57	43 44.33	35 36.08	1 1.03%	—	—	—
Apical dots	97	13 13.40	62 63.92	22 22.68%	—	—	—	—
Flatness of fruit	97	27 27.84	49 50.52	17 17.53	4 4.12	0 0%	—	—
Smoothness of fruit	97	23 23.71	59 60.82	15 15.46	0 0	0 0%	—	—
Thinness of rind	96	58 60.42	36 37.50	2 2.08	0 0	0 0%	—	—
Thinness of segment wall	96	93 96.88	3 3.13	0 0	0 0	0 0%	—	—
Color of pulp	96	79 82.29	17 17.71	0 0	0 0	0 0%	—	—
Size of central column	96	0 <sup>*</sup> 0	1 1.04	44 45.83	42 43.75	9 9.38%	—	—
Quantity of pith	96	0 0	1 1.04	69 71.88	22 22.92	4 4.16%	—	—
Quality of pulp	94	42 44.68	38 40.43	14 14.89	0 0	0 0%	—	—

The measurements of these fruits are given in Table 164.\*

Early in the year 1924, an advance pick of two fruits was collected from this bud variation branch and sent by Mr. TOGASHI. These fruits are described as follows :

Fruit No. 8147. Fruits green but look almost similar to Kawano Wase in shape, size, and smoothness of the surface. Oil cell dots large and convex, forming no fovea. Apex only slightly flattened, not areolate. Disk enlarged but demarcation clear, bordered by depressed furrows. The section is exactly like a Wase with a moderately thin rind, moderately small central column, thick wall, solid pith and remarkably coarse-grained pulp. Taste of pulp is acidulous and not good. Vesiculation is very clear.

Fruit No. 8148. Smaller and not Wase-like in shape, but beautifully colored. Areola almost absent. Calyx with sinuous depression, size normal. Oil cell dots of the surface large, convex, and much crowded. Cross-section is very much like Wase : one segment is abnormally large. Wall thin, rind thin, central column small, less pithy. Pulp deep-colored, texture rather fine, juicy, not very acidulous but slightly insipid, not good to the taste. Vesiculation more or less anastomose.

The average of these two fruits is given below :

Girth	Height	D/H Index	Weight	Calyx	No. Segm'ts.	Rind	Central column
22.3 cm.	5.3 cm.	1.34	136 gm.	11 mm	10.5	2.5 mm.	15.25 mm.

The tree was repeatedly examined in both 1924 and 1926. It was proved that the leaves of the variation branch are not typical Wase, being rather slender, erect, boat-shaped, but they are unquestionably slightly light-colored and a little over-crowded. Branchlets bearing these leaves are rather erect, straight, with elongated internodes, looking entirely different from those of Wase.

The following note was taken in investigating 39 fruits picked in 1924 :

Fruits ranging from large to small, average medium, shape rather tall, involving very flat fruits. Some are well-colored, some still remain

\* PL. XXXVI, Fig. 2.

greenish (even after being in cold storage for a month). The largest fruit appears very much like Wase, having a distinct double ring around the calyx. In smaller fruits the double ring not present, but instead of it, a strong demarcation of the disk occurs almost marking a deep sinuation. Average shape of smaller fruits is taller than the ordinary Owari fruits, but not typically Wase-like, not being roundish-rectangular. Apex rather peculiar, not depressed, often only sinuate at the stylar end, its surrounding part is somewhat protruded. Areola often strongly marked, often in double circles. Navels not prominent. Calyx usually large; disk not typically expanding, but in large fruits it shows a tendency to expand. Surface of fruit is quite rough with large convex oil cell dots, not with fovea pitting.

The cross-section of three largest fruits (Nos. 7008, 7009, 7100) has a more or less thick rind, thick segment wall, distinctly coarse vesicles, medium-sized central column, abundant pith, and more or less light-colored, insipid, non-acidic pulp. The cross-section of the rest of the fruits: Rind not thin, usually thicker than medium, wavy, brittle, often hard in late-bloom fruits; oil cells large. Segments often very irregular, some more or less uniform, not many in number. Wall very thick, often quite remarkable. Central column large than medium, pith abundant in quantity. Color of pulp varying from deep to medium; deep-colored ones are sweet and palatable, others are all more or less bitterish and not good in taste, although the texture is soft and juicy. Vesiculation is very coarse, indistinct, showing no tendency to become white and dry. It is not known whether the deterioration of the quality is caused by the comparatively long period in cold storage, or is due to the poor condition of the tree. The fruits were tested on December 13, 1924.

The measurements of these fruits are given in Table 165.\*

Judging from these critical examinations, the fruit of TAKAHASHI's bud variation tree is unquestionably a strain of Wase, the character of which is not strongly differentiated. In the first year, when the branch was over-bearing, the fruit was quite small and flat, almost appearing not

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\* PL. XXXVI, Fig. 4.

TABLE 165.

MEASUREMENT OF 39 WASE FRUITS (NOS. 9008-9046) FROM TAKAHASHI'S  
BUD VARIATION TREE AT KAWAMURA, KANAGAWA PREFECTURE.  
LOT NO. 132 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.37 cm.	4.95 cm.	1.31	107.60 gm.	10.41 mm.	10.23	2.85 mm.	13.14 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	39	—	—	—	—	—	14	35.90%
Sinuate based fruits	39	—	—	—	—	—	19	48.72
Semi-sinuate based fruits	39	—	—	—	—	—	0	0
Areolated fruits	39	—	—	—	—	—	18	46.15
Frs. with undeveloped calyx lobes	39	—	—	—	—	—	3	7.69
Frs. with long narrow calyx lobes	39	—	—	—	—	—	0	0
Fruits containing seeds	39	—	—	—	—	—	0	0
Apical depression	39	0 0	8 20.51	27 69.23	4 10.26	—	—	—
Apical dots	39	24 61.54	9 23.08	6 15.38%	—	—	—	—
Flatness of fruit	39	6 15.38	17 43.59	14 35.90	1 2.56	1 2.56%	—	—
Smoothness of fruit	39	1 2.56	27 69.23	3 7.69	8 20.51	0% 0	—	—
Thinness of rind	39	4 10.26	14 35.90	17 43.59	4 10.26	0 0%	—	—
Thinness of segment wall	39	3 7.69	9 23.08	19 48.72	7 17.95	1 2.56%	—	—
Color of pulp	39	12 30.77	19 48.72	8 20.51	0 0	0 0%	—	—
Size of central column	39	0 0	13 33.33	22 56.41	4 10.26	0 0%	—	—
Quantity of pith	39	2 5.13	24 61.54	12 30.77	1 2.56	0 0%	—	—
Quality of pulp	38	3 7.89	9 23.68	26 68.42	0 0	0 0%	—	—

like Wase, but in later years, when the crop was not large, at least some fruits showed characteristics of Wase. The vegetative part of the branch is generally not marked as is Wase, and the growth looks more vigorous than that of Kawano Wase. It may be useful in this respect, although the quality of the fruit is not excellent.

### OWARI FRUITS FROM TAKAHASHI'S BUD VARIATION TREE

In 1923, the fruit of the normal part of TAKAHASHI's bud variation tree was studied and the following description was given.

The fruit (Nos. 7157-7209) is decidedly flatter than that of the Wase part, but all other characters are not strongly marked as different. Size medium-small, flat, the depression of the stem-end is not prominent when examined in an over-ripe condition. The surface is very slightly less smooth than the Wase lots. Calyx rather small, but slightly more developed than the above, and areola slightly better developed. Navel decidedly less developed than the Wase. Apical depression is a trifle more concave than the above.

The cross-section has thin rind, thin segment wall, medium-sized central column and medium amount of pith. The pulp is deep-colored, distinctly fine-grained, tasting moderately good in quality.

The measurements of these fruits are given in Table 166.\*

The crop of the normal part of TAKAHASHI's bud variation tree was re-examined in 1925, the result being given below :

Fruits medium to medium-small, equally flattened and beautiful-looking, even-surfaced or homogeneously light-pitted, never roughened. Apex broadly concave in large fruits, shallow or almost flat in smaller fruits. Areola mostly present but not strongly marked. Dots present around the styler point. Navel present in larger fruits. Base broadly concave or nearly flattened, rarely sinuous, surrounded by flattened area, never narrowed at the base. Calyx normal, lobes well developed, entirely covering the disk. Radial grooves not conspicuous, except when they form very short furrows in a few fruits. Beautifully colored, good looking Owari.

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\* PL XXXVII, Fig. 1.

TABLE 166.

MEASUREMENT OF 53 OWARI FRUITS (NOS. 7157-7209) OF TAKAHASHI'S  
BUD VARIATION TREE, AT KAWAMURA, KANAGAWA PREFECTURE.  
LOT NO. 97 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. of Segm'ts.	Rind	Center
16.80 cm.	3.83 cm.	1.39	59.96 gm.	9.41 mm.	10.77	2.26 mm.	10.44 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	53	—	—	—	—	—	6	% 11.32
Sinuate based fruits	53	—	—	—	—	—	0	0
Semi-sinuate based fruits	53	—	—	—	—	—	8	15.09
Areolated fruits	53	—	—	—	—	—	41	77.36
Frs. with undeveloped calyx lobes	53	—	—	—	—	—	8	15.09
Frs. with long narrow calyx lobes	53	—	—	—	—	—	0	0
Fruits containing seeds	52	—	—	—	—	—	2	3.77
Apical depression	53	13 24.53	23 43.40	17 32.07	0 0%	—	—	—
Apical dots	53	31 58.49	13 24.53	9 16.98%	—	—	—	—
Flatness of fruit	53	34 64.15	17 32.07	2 3.77	0 0	0 0%	—	—
Smoothness of fruit	53	1 1.89	26 49.06	26 49.06	0 0	0 0%	—	—
Thinness of rind	52	39 75.00	13 25.00	0 0	0 0	0 0%	—	—
Thinness of segment wall	52	43 82.69	9 17.31	0 0	0 0	0 0%	—	—
Color of pulp	52	42 80.77	10 19.23	0 0	0 0	0 0%	—	—
Size of central column	52	0 0	1 1.92	37 71.15	14 26.92	0 0%	—	—
Quantity of pith	52	0 0	2 3.85	49 94.23	1 1.92	0 0%	—	—
Quality of pulp	52	0 0	28 53.85	24 46.15	0 0	0 0%	—	—



TABLE 167.

MEASUREMENT OF 21 OWARI FRUITS (NOS. 9814-9834) FROM TAKAHASHI'S  
BUD VARIATION TREE, AT KAWAMURA, SHIDZUOKA PREFECTURE.  
LOT NO. 153 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.89 cm.	4.11 cm.	1.46	81.39 gm.	10.81 mm.	11.14	2.42 mm.	11.64 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	21	—	—	—	—	—	10	47.62%
Sinuate based fruits	21	—	—	—	—	—	2	9.52
Semi-sinuate based fruits	21	—	—	—	—	—	0	0
Areolated fruits	21	—	—	—	—	—	15	71.43
Frs. with undeveloped calyx lobes	21	—	—	—	—	—	2	9.52
Frs. with long narrow calyx lobes	21	—	—	—	—	—	0	0
Fruits containing seeds	21	—	—	—	—	—	0	0
Apical depression	21	2 9.52	12 57.14	5 23.81	2 9.52%	—	—	—
Apical dots	21	0 0	9 42.86	12 57.14%	—	—	—	—
Flatness of fruit	21	12 57.14	8 38.10	1 4.76	0 0	0 0%	—	—
Smoothness of fruit	21	0 0	10 47.62	11 52.38	0 0	0 0%	—	—
Thinness of rind	21	5 23.81	9 42.86	7 33.33	0 0	0 0%	—	—
Thinness of segment wall	21	14 66.67	7 33.33	0 0	0 0	0 0%	—	—
Color of pulp	21	20 95.24	1 4.76	0 0	0 0	0 0%	—	—
Size of central column	21	0 0	1 4.76	13 61.90	6 28.57	1 4.76%	—	—
Quantity of pith	21	0 0	4 19.05	17 80.95	0 0	0 0%	—	—
Quality of pulp	20	14 70.00	6 30.00	0 0	0 0	0 0%	—	—

Section : Thickness of the rind variable from thin to medium, central column also ranging from medium to small. Pulp almost all well colored. Flavor slightly variable from good to medium-good, being mostly good. Rind rather thick and dense, but not solid. Oil cells small, uniform in shape. Pith medium or slightly more than medium, not much varying in quantity. Average quality is fairly good, although not excellent.

The measurements of these fruits are given in Table 167.\*

In conclusion, the original tree which bears a bud variation branch is an Owari with moderately small-sized fruits, flat in shape and good in quality.

### MIYAGAWA WASE, A BUD VARIATION STRAIN WITH DURABLE SKIN

In the summer of 1923, the writer's attention was called by Mr. Saichi MAEYAMA to a nurseryman who was advertising a peculiar, early-maturing Satsuma, originally coming from the garden of Dr. Kenkichi MIYAGAWA. In visiting the nurseryman, named Kamekichi TANAKA, at Yamakawa-mura, Fukuoka Prefecture, the writer learned that he was propagating several thousand nursery plants which were claimed to have come from a single branch of Dr. MIYAGAWA's tree, given by Mrs. MIYAGAWA, formerly president of the Girls' Business School. The writer was later taken to Dr. MIYAGAWA's plant by his wife, and was able to identify it as a case of bud variation Wase Satsuma orange. The description of the tree is given below (PL. LII, Fig. 6, 7 and 8):

The tree is one of the three large Satsuma trees planted in the backyard, and were given by Mr. Takeji YOSHIDA, former director of Fukuoka Agricultural Experiment Station, as descendents of a prize-winning tree. This is the middle tree, 2.6 m. away from the other trees, having a diameter of 2.9 m. in E-W spread, 2.3 m. in N-S spread, and a height of 2.3 m. The main trunk is straight, is 5.5 cm. long, and forks into thick major branches. The western branch is rather upright, bearing normal fruits.

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\* PL. XXXVII, Fig. 2.

The eastern branch is cut at 35 cm. from the starting point and two branches simultaneously start from here in the opposite directions, keeping to quite a large angle forming nearly a straight line. (The interior, or the western branch soon divides into two limbs, which were cut down and top-worked with Wase scion in 1926). The exterior, or eastern branch, extends about 45 cm. and then divides into three limbs almost at the same place. The middle limb of about 20 cm. girth grows slightly upward and bends down, stretching about 90 cm. outward and upward. This limb shows the variation while the other two on both sides are normal.\* The bent part of the middle limb is at first smooth, but later becomes rough and is somewhat twisted-looking. The whole tree looks rather weak and bears many drooping shoots.\*\* The leaves of the normal part are large, narrow, attached to long shoots, but those on the variation limb are lozenge-shaped, twisted, and lighter colored. The internodes of the variation limb do not seem shortened, even when the sprouts are crowded in certain parts, and the limb looks very vigorous as does a Wase. Soil is black sandy loam not looking very fertile. The surface is covered with pebbles and a great deal of the same material is sunk in the ground to secure porosity, on account of the poor drainage due to the low, flat condition of the ground. For fertilizer, about 2 shô (3.6 litres) of rape seed cake per tree is applied. The tree was planted in about 1900 and the fruits on this particular limb began to attract the attention of children, as they were capable of being picked when other Satsuma fruits were still green. The fruits of the variation limb won the first prize at the prefectural agricultural exhibition held in 1918, and it then became popular. Many bud sticks were taken by the local agricultural society under the direction of officers, but their traces were all lost. Two plants propagated in 1918 are in Dr. MIYAGAWA's garden, both showing characteristics of the original Wase branch. Mrs. MIYAGAWA said that the fruit matures about 20 days early, and the fruit of this year were all picked before November 10th. From her storage box 3 fruits of the

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\* These normal limbs were removed in 1926.

\*\* The condition of the tree improved greatly in the succeeding year.

Wase and 4 fruits of the normal part were given to the writer for investigation, the former is described as follows :

Three fruits picked about Nov. 15, 1923 (out of 20 fruits now remaining). Shape round, some more or less conical, exceedingly large-sized, uniformly even, with very large convex oil cell dots. Apex simply flattened or more or less rounded, never conspicuously depressed. Areola and navel do not exist, and dots reach to the styler point. Base sinuous around large circular area. Calyx large-sized, lobes sometimes elongated, disk inconspicuously enlarged. Surface tight, never becoming puffy, good-colored and shiny; some fruit being rather light in weight after a month's storage. Perfectly healthy without blemishes.

The cross-section : Rind comparatively thick, wall also rather thick, central column smaller than medium with a moderate amount of pith. Pulp deep-colored, tasting good. Vesiculation very coarse, conspicuously netted, as typical Wase.

Fruit No. 7884, was given as a Wase, but it has a flat shape and distinctly small vesiculation, and proved not to be Wase. It may have been picked from a normal branch of the same tree.

The measurements of these 3 fruits (Nos. 7881-7883) are given in Table 168.\*

In 1924, the writer was permitted to examine the entire Wase crop of the original tree and of a second generation tree. The description of these fruits is given as follows :

64 fruits from the original tree (Nos. 8622-8685).

Fruits large-sized; shape very much rounded, in many cases with conical base; horizontal outline somewhat irregular, often with one-sided projection toward the styler end due to the abnormal enlargement of a certain segment. Apex mostly slightly depressed, usually simply flattened or rarely convex. Dots in many cases present up to the styler point; if absent, the dot-less area is not very large. Areola very often exists. Base occasionally sinuate and not so flat as in the Kawano Wase: striation usually present. Calyx is not large-sized, and often with undeveloped

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\* PL. XXXVII, Fig. 3.

TABLE 168.

MEASUREMENT OF 3 FRUITS (NOS. 7881-7883) OF MIYAGAWA WASE FROM  
SHIROUCHIMURA, YAMATO-GUN, FUKUOKA PREFECTURE.  
LOT NO. 114 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
23.97 cm.	5.90 cm.	1.30	164.00 gm.	11.33 mm.	10.33	3.42 mm.	14.33 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	3	—	—	—	—	—	0	% 0
Sinuate based fruits	3	—	—	—	—	—	1	33.33
Semi-sinuate based fruits	3	—	—	—	—	—	1	33.33
Areolated fruits	3	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	3	—	—	—	—	—	1	33.33
Frs. with long narrow calyx lobes	3	—	—	—	—	—	0	0
Fruits containing seeds	3	—	—	—	—	—	0	0
Apical depression	3	0 0	0 0	3 100.00	0 0%	—	—	—
Apical dots	3	0 0	1 33.33	2 66.67%	—	—	—	—
Flatness of fruit	3	0 0	1 33.33	1 33.33	0 0	1 33.33%	—	—
Smoothness of fruit	3	0 0	1 33.33	2 66.67	0 0	0 0%	—	—
Thinness of rind	3	1 33.33	2 66.67	0 0	0 0	0 0%	—	—
Thinness of segment wall	3	1 33.33	2 66.67	0 0	0 0	0 0%	—	—
Color of pulp	3	3 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	3	0 0	0 0	2 66.67	1 33.33	0 0%	—	—
Quantity of pith	3	0 0	0 0	3 100.00	0 0	0 0%	—	—
Quality of pulp	3	2 66.67	1 33.33	0 0	0 0	0 0%	—	—

lobes, rarely with elongated ones. Disk usually small and the demarcation is clear, but the size is undoubtedly larger than in Owari. About 10% of the fruits have a typically enlarged disk, like that of Kawano Wase. A double ring around the disk is common. Surface of fruits in part well developed, with bright orange color, but part still yellowish. Oil cell dots always very prominent, but in large fruit the apical half is often pitted.

Cross-section: Rind varying from thin to medium in larger fruits, but thinner in smaller ones. Segment wall comparatively thick. Central column smaller than medium, average medium-small, with rather abundant pith. Segments rather uniform in size. Pulp meaty, with not abundant juice, sometimes white and dried. Flavor generally medium-good, often very good tasting. Vesiculation conspicuously clear, salmon-flesh structure is marked; in smaller fruits vesicle wall is thinner.

Judging from these characters, Miyagawa Wase is a large, tall, fruiting strain with a comparatively rough skin and with better qualities for keeping and shipping than the average Wase Satsumas. Although the fruit is large-sized and somewhat rough, the quality of pulp seems to be fairly good.

12 fruits from a second generation tree (Nos. 8686-8697).

Fruits almost exactly similar to the above, tall fruits predominating and the color slightly lighter. The section is also similar but the rind is thinner and pulp more juicy: Vesiculation slightly less distinct. Quality is slightly inferior to those from the original tree, but some individuals have a good taste.

The measurements of both 1924 crops (lots 126 and 127) are given in Tables 169\* and 170.\*\*

A number of fruits of these lots were kept in cold storage until March 7, 1925 to try how well they keep. The result of this storage test is as follows:

Fruits kept very well without shrinkage of segments. Rind almost adherent to the pulp ball. It is worthy of note that the smaller fruits

\* PL. XXXVII, Fig. 4.

\*\* PL. XXXVIII, Fig. 1.

TABLE 109.

MEASUREMENT OF 64 WASE FRUITS (NOS. 8622-8685) FROM MIYAGAWA'S  
ORIGINAL BUD VARIATION TREE, AT SHIROUCHI, FUKUOKA  
PREFECTURE. LOT NO. 126 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.94 cm.	5.66 cm.	1.29	158.75 gm.	10.44 mm.	10.67	3.04 mm.	12.31 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	64	—	—	—	—	—	38	59.38
Sinuate based fruits	64	—	—	—	—	—	22	34.38
Semi-sinuate based fruits	64	—	—	—	—	—	0	0
Areolated fruits	64	—	—	—	—	—	41	64.06
Frs. with undeveloped calyx lobes	64	—	—	—	—	—	8	12.50
Frs. with long narrow calyx lobes	64	—	—	—	—	—	2	3.13
Fruits containing seeds	64	—	—	—	—	—	4	6.25
Apical depression	64	0 0	0 0	40 62.50	24 37.50%	—	—	—
Apical dots	64	8 12.50	31 51.56	23 35.94%	—	—	—	—
Flatness of fruit	64	1 1.56	21 32.81	25 39.06	15 23.43	2 3.13%	—	—
Smoothness of fruit	64	21 32.81	31 48.44	12 18.75	0 0	0 0%	—	—
Thinness of rind	64	24 37.50	12 18.75	21 32.81	7 10.94	0 0%	—	—
Thinness of segment wall	64	12 18.75	24 37.50	18 28.13	10 15.63	0 0%	—	—
Color of pulp	64	21 32.81	24 37.50	13 20.31	4 6.25	2 3.13%	—	—
Size of central column	64	0 0	7 10.94	15 23.43	29 45.31	13 20.31%	—	—
Quantity of pith	64	11 17.19	28 43.75	24 37.50	1 1.56	0 0%	—	—
Quality of pulp	63	20 31.75	22 34.92	16 25.40	4 6.35	1 1.59%	—	—

TABLE 170.

MEASUREMENT OF 12 WASE FRUITS (Nos. 8686-8697) FROM A SECOND  
GENERATION TREE OF MIYAGAWA WASE, AT SHIROUCHI,  
FUKUOKA PREFECTURE. LOT NO. 127 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.20 cm.	5.53 cm.	1.28	145.83 gm.	10.42 mm.	10.08	2.25 mm.	12.46 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	12	—	—	—	—	—	9	% 75.00
Sinuate based fruits	12	—	—	—	—	—	2	16.67
Semi-sinuate based fruits	12	—	—	—	—	—	0	0
Areolated fruits	12	—	—	—	—	—	8	66.67
Frs. with undeveloped calyx lobes	12	—	—	—	—	—	2	16.67
Frs. with long narrow calyx lobes	12	—	—	—	—	—	0	0
Fruits containing seeds	12	—	—	—	—	—	0	0
Apical depression	12	0 0	0 0	9 75.00	3 25.00%	—	—	—
Apical dots	12	1 8.33	4 33.33	7 58.33%	—	—	—	—
Flatness of fruit	12	0 0	2 16.67	6 50.00	2 16.67	2 16.67%	—	—
Smoothness of fruit	12	6 50.00	3 25.00	3 25.00	0 0	0 0%	—	—
Thinness of rind	12	8 66.67	4 33.33	0 0	0 0	0 0%	—	—
Thinness of segment wall	12	0 0	5 41.67	6 50.00	1 8.33	0 0%	—	—
Color of pulp	12	8 66.67	4 33.33	0 0	0 0	0 0%	—	—
Size of central column	12	0 0	1 8.33	7 58.33	2 16.67	2 16.67%	—	—
Quantity of pith	12	0 0	5 41.67	7 58.33	0 0	0 0%	—	—
Quality of pulp	12	4 33.33	3 25.00	5 41.67	0 0	0 0%	—	—



having a thin skin and well mature pulp kept better than the larger ones, which were not fully mature, and which tend to become readily insipid. Every fruit retained abundant juice without deterioration of flavor, except a few green fruits which turned bitter. It is, therefore, desirable to use only well ripened fruits for storage, because such fruits will never change flavor. Rough fruits lose their sweetness rather quickly and degenerate soon.

As to the vigorous nature of this Wase Satsuma strain, the following statement was made by the writer in 1925<sup>(72)</sup>:

"The fruit is rather too globular and the rind appears too rough to warrant a high standing in the market, but it seems that the productivity and vigor is exceedingly high in comparison with other strains of Wase. The writer noticed [in the nursery of Kamekichi TANAKA] a top-worked shoot making an elongation of 1.6 meters in one growing season, and such remarkable growth has never met with in any other strain of bud variation Wase Satsuma."

There are a few unqualified reports about this bud variation after the author's first report<sup>(3)(6)(76)</sup>. FUJIWARA<sup>(35)</sup> states that the fruit of MIYAGAWA's Satsuma (Miyagawa Wase) is not always large but is mixed with smaller grades, and the shape is too round. He further states, however, that the quality is good, according to the statement of Ikuta UCHIDA, representative of the Central Horticultural Society, and many persons who tried the fruit agree with him. The editor of Chûô Engei (Central Horticulture)<sup>(6)</sup> admits the sweetness of this fruit is greater than that of Kawano Wase, and its nature more resistant to the black rot, caused by *Gloeosporium foliicorum*.

These reputations of the Miyagawa Wase are not to be regarded as authentic, but the fact is clear that the fruit of this strain is worth criticizing from various angles, since it is apparently more resistant to rough treatment and longer storage, suggesting the possibility of planting on a larger scale.

### NORMAL PART OF MIYAGAWA'S BUD VARIATION TREE

Only 4 fruits were available from the normal part of MIYAGAWA's bud variation tree in 1923. These were decidedly smaller in size than Wase fruits, with flatter outline, more pitted surface, smaller calyx, and

TABLE 171.

MEASUREMENT OF 4 FRUITS (NOS. 7884-7887) FROM NORMAL PART OF MIYAGAWA'S BUD VARIATION TREE, AT SHIROUCHI, FUKUOKA PREFECTURE. LOT NO. 115 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.10 cm.	4.95 cm.	1.96	105.75 gm.	9.00 mm.	11.75	3.00 mm.	13.85 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	4	—	—	—	—	—	1	% 25.00
Sinuate based fruits	4	—	—	—	—	—	3	75.00
Semi-sinuate based fruits	4	—	—	—	—	—	0	0
Areolated fruits	4	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	4	—	—	—	—	—	1	25.00
Frs. with long narrow calyx lobes	4	—	—	—	—	—	0	0
Fruits containing seeds	4	—	—	—	—	—	2	50.00
Apical depression	4	0 0	1 25.00	2 50.00	1 25.00%	—	—	—
Apical dots	4	0 0	2 50.00	2 50.00%	—	—	—	—
Flatness of fruit	4	0 0	2 50.00	1 25.00	0 0	1 25.00%	—	—
Smoothness of fruit	4	0 0	1 25.00	3 75.00	0 0	0 0%	—	—
Thinness of rind	4	2 50.00	2 50.00	0 0	0 0	0 0%	—	—
Thinness of segment wall	4	2 50.00	2 50.00	0 0	0 0	0 0%	—	—
Color of pulp	4	4 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	4	1 25.00	0 0	1 25.00	2 50.00	0 0%	—	—
Quantity of pith	4	0 0	1 25.00	3 75.00	0 0	0 0%	—	—
Quality of pulp	4	0 0	2 50.00	1 25.00	1 25.00	0 0%	—	—

TABLE 172.

MEASUREMENT OF 23 FRUITS (NOS. 10206-10226, 10010-10011) FROM NORMAL PART  
OF MIYAGAWA'S BUD VARIATION TREE, IN FUKUOKA PREFECTURE.  
LOT NO. 163 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.73 cm.	5.23 cm.	1.26	113.96 gm.	9.56 mm.	10.52	3.32 mm.	10.80 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	23	—	—	—	—	—	3	13.04
Sinuate based fruits	23	—	—	—	—	—	13	56.53
Semi-sinuate based fruits	23	—	—	—	—	—	7	30.43
Areolated fruits	23	—	—	—	—	—	15	65.22
Frs. with undeveloped calyx lobes	23	—	—	—	—	—	6	26.09
Frs. with long narrow calyx lobes	23	—	—	—	—	—	0	0
Fruits containing seeds	23	—	—	—	—	—	6	26.09
Apical depression	23	1 4.35	1 4.35	9 39.13	12 52.17%	—	—	—
Apical dots	23	1 4.35	4 17.39	18 78.26%	—	—	—	—
Flatness of fruit	23	0 0	0 0	5 21.74	11 47.83	7 30.43%	—	—
Smoothness of fruit	23	0 0	2 8.70	15 65.22	6 26.09	0 0%	—	—
Thinness of rind	23	1 4.35	8 34.78	11 47.83	2 8.70	1 4.35%	—	—
Thinness of segment wall	23	3 13.04	9 39.13	8 34.78	2 8.70	1 4.35%	—	—
Color of pulp	23	20 86.96	3 13.04	0 0	0 0	0 0%	—	—
Size of central column	23	0 0	1 4.35	10 43.48	8 34.78	4 17.39%	—	—
Quantity of pith	23	5 21.74	8 34.78	10 43.48	0 0	0 0%	—	—
Quality of pulp	23	12 52.17	7 30.43	3 13.04	1 4.35	0 0%	—	—

more distinctly sinuate stem-end. Coloring was just the same (on Dec. 16, 1923) but the flavor was very inferior to Wase fruit. The measurements of these fruits are given in Table 171.\*

In 1924, 23 fruits from a branch of the normal part of the same tree were received for study. These fruits are described as follows:

Fruits medium to small, the difference not being very great; round, often high, quite rounded at the base, rarely protruding. Apex also rounded; when concave, its area is small. Areola occasionally present; navel generally closed; dots reaching to the styler point. Surface generally even, dots convex or concave, convex ones predominating and generally are not foveolate; deep-colored. Calyx small, the surrounding area usually sinuous without radial grooves.

In cross-section, rind varying from thick to medium-thin, hard, none of the of rind being truly thin, oil cells round and distinctly arranged in one row, inside layer raggy, adherent to or becoming free from the pulp ball. Central column rather small, pith sometimes very abundant but generally not conspicuously so. Segment wall thick to medium-thin. Pulp meaty, rather hard, flavor good to medium, some acidulous, not disagreeable nor bitter, but unquestionably of inferior quality. Vesiculation rather coarse and parallel.

From these characters, the plant is determined as Zairai, very common in this prefecture.

The measurements of these fruits are given in Table 172.\*\*

### AIKAWA WASE FROM NAGASAKI PREFECTURE

In the fall of 1923, the writer's attention was called by the late Mr. Seita HAMADA, former horticulturist of the Nagasaki Agricultural Experiment Station, to a bud variation tree in Ikiriki village, Nagasaki Prefecture. A visit by the writer was first made on December 15, 1923, to study the plant in the orchard of Takaichirô AIKAWA, at Karisoko, Yamagawachi, Ikiriki-mura, Nishisonoki-gun, Nagasaki-ken (PL. LII, Fig. 9). The tree is located in Obane plot, on a steep hillside facing the south-east. The

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\* PL. XXXVIII, Fig. 2.

\*\* PL. XXXVIII, Fig. 3.

terrace is planted with Satsumas in rows at a distance of 2.6 m., each row being about 3.5 m. wide. The tree in question is the 3rd tree from south on the 2nd terrace from the top, the tree being 2.4 m. in diameter (both E-W and N-S spreads) and 1.9 m. in height. It is a tree propagated in about 1908 by the father of the present owner, Eitarô AIKAWA, the bud of which came from a local plant. This is a vigorous tree, well-pruned, with comparatively few branches remaining, spreading on every direction in good order. The branches are strong and are more or less curved, bearing deep-colored, large, broad leaves somewhat crowded in appearance. The branch in question is small, about 5 years old, arising horizontally from the upper part of the main upright trunk spreading in a south-western direction. This branch has the mark of an injury at the lower surface of the thicker part near the bottom, and looks rather sick, bearing no strong shoots. The end of this limb is considerably drooping, and the leaves on it look almost normal, having no appreciable difference from those on the other parts. The owner has been watching very carefully since June, 1923, for differences in the habit of fruiting and later Mr. HAMADA decided it to be case of bud variation. The soil is brown loam with a certain amount of sand, containing no pebbles, and looking fertile. The ground is mulched with grasses. The fertilization is given at the ratio of nitrogen 10 kwan (37.5 kg.), phosphoric acid 11 kwan (41.25 kg.) and potash 5 kwan (18.75 kg.), with a mixed dose of silkworm pupa, dried fish, soy bean cake, sesamum pressed cake, super-phosphate of lime, etc.

One fruit was found remaining on the branch when the writer saw the plant (Dec. 5, 1923). It had a girth of 24 cm., height 5.8 cm., D/H index 1.31, weight 180 gm., diameter of calyx 9 mm., number of segments 10, thickness of rind 3-4 mm., and diameter of central column 18 × 15 mm. Surface typically smoothed with large convex oil cell dots. Shape medium in height, rectangular, both ends being shallowly depressed; areola and navel lacking, and the enlargement of calyx not pronounced. The cross-section shows typical Wase characters, such as thin rind, large oil cells, small central column, deep-colored and extremely coarse-grained pulp, tasting very good. This fruit (No. 7638, Lot No. 108 of 1923) proved an

TABLE 173.

MEASUREMENT OF 8 FRUITS (NOS. 7639-7646) FROM A NORMAL BRANCH  
OF AIKAWA'S BUD VARIATION TREE, AT YAMAGAWACHI, IKIRIKI,  
NAGASAKI PREFECTURE. LOT NO. 109 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.15 cm.	5.25 cm.	1.94	132.00 gm.	9.75 mm.	11.00	3.31 mm.	13.88 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	8	—	—	—	—	—	1	12.50%
Sinuate based fruits	8	—	—	—	—	—	1	12.50
Semi-sinuate based fruits	8	—	—	—	—	—	0	0
Areolated fruits	8	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	8	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	8	—	—	—	—	—	0	0
Fruits containing seeds	8	—	—	—	—	—	0	0
Apical depression	8	0 0	3 37.50	3 37.50	2 25.00%	—	—	—
Apical dots	8	2 25.00	3 37.50	3 37.50%	—	—	—	—
Flatness of fruit	8	2 25.00	3 37.50	1 12.50	2 25.00	0 0%	—	—
Smoothness of fruit	8	0 0	2 25.00	6 75.00	0 0	0 0%	—	—
Thinness of rind	8	1 12.50	5 62.50	2 25.00	0 0	0 0%	—	—
Thinness of segment wall	8	3 37.50	5 62.50	0 0	0 0	0 0%	—	—
Color of pulp	8	8 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	8	0 0	1 12.50	6 75.00	1 12.50	0 0%	—	—
Quantity of pith	8	0 0	0 0	8 100.00	0 0	0 0%	—	—
Quality of pulp	8	7 87.50	1 12.50	0 0	0 0	0 0%	—	—

unquestionable Wase, and HAMADA stated that the rest of the fruits picked before from the same branch were similar. Unfortunately, the branch died soon after the next spring season, but a young plant propagated from this limb was saved, which carries typical Wase characters.

Eight fruits from a normal branch (Nos. 7639-7646) were collected for comparison and a description of them is briefly as follows:

Fruits rather large, shape generally tall with the exception of a few flat ones, tall ones being not rectangular but nearly globose. Apex shallowly concave, sometimes lacking dots around the stylar point, areola lacking and navel rarely present. Base generally deeply depressed and carries grooves. Calyx large, often with double ring. Surface is pitted, although many dots are convex. Tight-skinned or rarely puffy, fully mature and well-colored.

Section, typical Owari of good quality. Rind and wall of segment medium-thin, central column medium-sized with medium quantity of pith. Pulp deep-colored, melting, good taste. Vesiculation fine, typical of Owari. The measurements of these fruits are given in Table 173.\*

### MATSUDA WASE, FROM ÔITA PREFECTURE

In December, 1923, six Satsuma orange fruits were sent to the author from Mr. Kôichi HIMENO, of Ôita Prefecture, for identification, with remarks designating that these fruits came from a very large tree owned by Bun MATSUDA, at Azamui, Minami-amabe-gun, Ôita-ken. Every fruit looked very beautiful, uniformly flat and good-colored, with a few affections of sour scab. Two fruits (Nos. 7433 and 7438) showed large, rough, convex oil cell dots, typical of Wase,\* but the rest (Nos. 7434-7437) had smaller, pitted dots, the contrast being remarkable large. In halving the fruits, every one had medium-thin rind, good-colored pulp, medium-thin segment wall, and variable-sized central column. The contrast between the first two and the rest was also very great in points, the former having an extremely coarse, rather discolored pulp, vesicles in anastomose

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\* PL. XXXVIII, Fig. 5.

\*\* PL. XXXIX, Fig. 1.

salmon-flesh structure, while the latter had deep-colored pulp with fine, parallel vesiculation. By careful comparison, the first two fruits showed more or less distinct, fine striations radiating from the calyx-end, while the others had more or less strongly sinuate bases with distinct, deep furrows. The taste of the first fruit (No. 7433) was saccharine, extremely good in quality, while the others were more or less acidulous. This examination proved that the sample was a mixture of Wase and Owari fruits, Nos. 7433 and 7438 being the former and the rest being the latter. This predicted the existence of a bud variation Wase branch on a plant which produced these sample fruits.

On January 10, 1924, the plant was visited (PL. LII, Fig. 10). It is located at Gyôran, called Otani orchard. It is on a very steep hillside about 90 m. from the bottom, facing the south, being in the fourth terrace from the bottom and the first tree from the east of a small valley. It is a tree of huge size, appearing almost 100 years of age, but later it was learned that the stock is Yamamikan (*Citrus intermedia* Hort.), and the age is not more than 60 years, the huge size alluded to is the effect of the stock. The spread of the tree is about 7.2 m. in both directions, and it is about 6.6 m. high. Branches are homogeneously spreading in all directions, not many in number, bearing many comparatively short, upright shoots. Lerves rather light-colored, upright and short, seems to be almost similar to Wase. Only one major branch running to the south-west, arising from nearly the bottom of trunk, bears typical Owari leaves. Although the tree was located on a dangerous cliff and is too big for one to make a definite determination of the variety without studying more fruits, it seemed likely to be a Wase tree throughout the whole plant, except the branch mentioned above. This includes the major trunk and all of its primary branches which form the top of the plant, and a large branch arising near the bottom in the opposite direction of the Owari branch stated before. The Wase character of the leaves seems most pronounced in branch B, which comes out from the trunk 60 cm. above the Owari branch. Judging from the habit of the tree, it looks as though the bud variation first started very young, as in the case of Nagata Wase, and it does not look to be a case of a



Wase plant bearing a reverting branch. At the time of the visit, 23 stored fruits of this tree were shown by the daughter of the owner, and 19 (82.6 %) were identified as Wase and the remaining 4 (17.4 %) as Owari, the percentage roughly agreeing with the approximate ratio of the area of both parts. The average weight of these Wase fruits was 116 gm., comparatively large fruiting in spite of the age of the tree, and the D/H index was 1.35, while that of the two fruits received in the previous year was 1.41. The soil of the orchard is a clayey loam with angular gravel, looking very fertile. Fertilization is not heavy and the tree is mulched with grasses. The tree was originally propagated by Sadagorô MATSUDA, the previous owner.

In the fall of 1924, 5 fruits of the Matsuda Wase were sent to the writer and they again proved to be Wase. The following note was taken when the fruit was examined.

Five fruits (Nos. 8142-8146). Received still green (Oct. 21, 1924).

Fruits medium-sized, very smooth, with large oil cell dots. Surface changing to yellow, one fruit being comparatively yellow, all not pitted, no blemishes. Apex slightly concave, with more or less large area around the stylar point which lacks oil cell dots. Areola present but lacking navel opening. Base has warts\* and consequently all are sinuous. Calyx small, normal, without enlarged disk.

Section: Rind thin, wall thin, central column medium-sized with medium quantity of pith. Segment number rather few. Pulp juicy still subacid in flavor, color medium to medium-light, with rather fine vesiculation (equal to that of the Yokushiji Wase fruit No. 8141, used for comparison). Flavor just as good as the Yakushiji Wase fruit No. 8141 (advance pick).

The measurements of these fruits are given in Table 174.\*

### NATSUME WASE FROM MIKKABI IN SHIDZUOKA PREFECTURE

Being encouraged by repeated discoveries of bud variation Wase strains of the Satsuma orange in Mikkabi, the author started a second

\* Abnormal wart at the base is a sign of an off-year crop.

\*\* PL. XXXIX, Fig. 2.

TABLE 174.

MEASUREMENT OF 5 FRUITS (NOS. 8142-8146) OF MATSUDA WASE, FROM  
AZAMUI, MINAMIAMABE-GUN, ÔITA PREFECTURE.

LOT NO. 116 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.70 cm.	4.24 cm.	1.39	77.20 gm.	9.40 mm.	9.80	2.05 mm.	12.80 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		%
Naveled fruits	5	—	—	—	—	0	0
Sinuate based fruits	5	—	—	—	—	5	100.00
Semi-sinuate based fruits	5	—	—	—	—	0	0
Areolated fruits	5	—	—	—	—	5	100.00
Frs. with undeveloped calyx lobes	5	—	—	—	—	0	0
Frs. with long narrow calyx lobes	5	—	—	—	—	0	0
Fruits containing seeds	5	—	—	—	—	0	0
Apical depression	5	0 0	0 0	1 20.00	4 80.00%	—	—
Apical dots	5	3 60.00	2 40.00	0 0%	—	—	—
Flatness of fruit	5	2 40.00	3 60.00	0 0	0 0	0 0%	—
Smoothness of fruit	5	5 100.00	0 0	0 0	0 0	0 0%	—
Thinness of rind	5	5 100.00	0 0	0 0	0 0	0 0%	—
Thinness of segment wall	5	5 100.00	0 0	0 0	0 0	0 0%	—
Color of pulp	5	0 0	1 20.00	4 80.00	0 0	0 0%	—
Size of central column	5	0 0	1 20.00	4 80.00	0 0	0 0%	—
Quantity of pith	5	0 0	0 0	5 100.00	0 0	0 0%	—
Quality of pulp	5	0 0	0 0	0 0	3 60.00	2 40.00%	—

series of investigations in the same town in the fall of 1924, resulting in a find of five new strains of independent Wase bud mutants, the outline of which was briefly reported before<sup>(178)</sup>. Mr. Ken'itsu, MATSUI of Mikkabi was engaged in making a provisional survey of these mutants and the entire discoveries are here credited to his strenuous effort.

The first of these Wase mutations, the Natsume Wase, is located in an orchard owned by Kakujirô NATUME at Nueshiro, Mikkabi-chô, Inasa-gun, Shidzuoka-ken (PL. LII, Fig. 11 and 12). This is the 6th tree from the south on the 3rd terrace from the bottom, in a sloping orchard facing the Lake of Hamana. This is a small tree of 2.6 m. in N-S spread, 2.45 m. in E-W spread and 1.6 m. in height. The whole tree is pruned to a good shape, and the leaves are deep-colored with frequent attacks of leaf-rolling months, causing water sprouts to stand up in many places. Normal leaves large, attached to nodes rather far apart from each other, typical of Owari. The trunk is 26.4 m. in girth, dividing into three at about 30 cm. from the ground. The major branch on the northern side runs straight for a distance of about 60 cm. and there sends out a slender horizontal branch about 43 cm. long. This branch curves down slightly at the end and there forks into two limbs. The upper horizontal limb bears the variation shoot, at 80 cm. from the ground. This shoot goes up about 12 cm. and then curves down about 27 cm. in length and then bears crowded sprouts. This miniature sprout about 24 cm. in length, bore 12 fruits in 1924, but 4 being lost, 8 came to the writer's hand for investigation. In this year, the condition of the leaves of the sport branch was very poor due to over-bearing, but no appreciable difference from the leaves of the other parts was noticed in the succeeding years, except a little abrupt acuteness of the base of the leaf. The soil of the orchard is clayey loam with small angular pebbles, and the tree is mulched with straw and looks very well cared for. During the winter time, the whole tree is covered with a straw mat to protect it from the cold north wind blowing from the lake. (Observed on March 18, 1925.) The origin of this tree is not known. It was planted about 1906, being a purchased tree. The bud variation was known to the owner for several years, and he once brought the fruit to

TABLE 175.

MEASUREMENT OF 8 FRUITS (NOS. 9881-9888) OF NATSUME WASE, FROM  
MIKKABI IN SHIDZUOKA PREFECTURE.  
LOT NO. 156 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.01 cm.	4.45 cm.	1.36	87.78 gm.	10.86 mm.	10.25	2.34 mm.	11.25 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	8	—	—	—	—	—	3	% 37.50
Sinuate based fruits	8	—	—	—	—	—	2	25.00
Semi-sinuate based fruits	8	—	—	—	—	—	1	12.50
Areolated fruits	8	—	—	—	—	—	1	12.50
Frs. with undeveloped calyx lobes	7	—	—	—	—	—	6	85.71
Frs. with long narrow calyx lobes	7	—	—	—	—	—	0	0
Fruits containing seeds	8	—	—	—	—	—	0	0
Apical depression	8	0 0	1 12.50	3 37.50	4 50.00%	—	—	—
Apical dots	8	3 37.50	1 12.50	4 50.00%	—	—	—	—
Flatness of fruit	8	0 0	3 37.50	5 62.50	0 0	0 0%	—	—
Smoothness of fruit	8	2 25.00	6 75.00	0 0	0 0	0 0%	—	—
Thinness of rind	8	7 87.50	1 12.50	0 0	0 0	0 0%	—	—
Thinness of segment wall	8	8 100.00	0 0	0 0	0 0	0 0%	—	—
Color of pulp	8	8 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	8	0 0	0 0	3 37.50	5 62.50	0 0%	—	—
Quantity of pith	8	0 0	1 12.50	7 87.50	0 0	0 0%	—	—
Quality of pulp	8	7 87.50	1 12.50	0 0	0 0	0 0%	—	—

the town office, inquiring about its value. Being afraid of secret propagation of the mutant strain, the owner usually covers the branch with straw, because the fruit might attract the attention of people walking on the highway very near the orchard.

The tree was watched until 1926 and no remarkable change occurred in the characters of the leaf and the fruit. The following is the description of the fruits received in 1924.

Fruits medium in size, rather small as Wase, shape from round to comparatively flat, some with a more or less pointed base due to the heavy cluster and from being pressed by other fruits. Apex flattened or rounded, or merely broad-depressed, with dots nearly reaching to the stylar point. Areola almost lacking. Navel present or absent, not prominent if existing. Base rounded, calyx-end sinuous but only slightly pushed in. Calyx normal, large, rather elevated, disk more or less enlarged but demarcation clear, radial striations not present but indistinct furrows run for a short distance. Surface smooth, color normal, oil cell dots large, prominent, close.

Cross-section: Rind thin (not very thin), wall also thin, central column rather small, up to medium size, pith generally medium in quantity. Segments not many. Pulp extremely intense in color, juice never dries up, beautiful-looking, good flavor, excellent quality, although slightly over-ripe. Vesicles coarse, anastomose and thin walled.

The measurements of these fruits are given in Table 175.\*

### NORMAL PART OF THE NATSUME WASE TREE

Twenty-one fruits (Nos. 9860-9880) were received from a branch of the normal part of the Natsume Wase tree at Mikkabi Shidzuoka Prefecture. A description of these fruits is given below:

Fruits ranging from medium to small, round, rather soft, looking somewhat like Wase except for the stem-end characters. Apex slightly concave, areola mostly present, dots around the stylar point often lacking. Base distinctly sinuous, no furrows radiating from the stem-end. Calyx

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\* PL. XXXIX, Fig. 3.

TABLE 176.

MEASUREMENT OF 21 FRUITS (NOS. 9800-9880) FROM THE NORMAL PART  
OF NATSUME'S FIRST BUD VARIATION TREE AT MIKKABI,  
SHIDZUOKA PREFECTURE. LOT NO. 155 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.65 cm.	414 cm.	1.34	82.62 gm.	10.57 mm.	10.10	2.67 mm.	10.29 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	21	—	—	—	—	—	1	% 4.76
Sinuate based fruits	21	—	—	—	—	—	14	66.67
Semi-sinuate based fruits	21	—	—	—	—	—	7	33.33
Areolated fruits	21	—	—	—	—	—	9	42.86
Frs. with undeveloped calyx lobes	21	—	—	—	—	—	3	14.29
Frs. with long narrow calyx lobes	21	—	—	—	—	—	0	0
Fruits containing seeds	21	—	—	—	—	—	0	0
Apical depression	21	2 9.52	9 42.86	7 33.33	3 14.29%	—	—	—
Apical dots	21	8 38.10	11 52.38	2 9.52%	—	—	—	—
Flatness of fruit	21	1 4.76	1 4.76	4 19.05	9 42.86	6 28.57%	—	—
Smoothness of fruit	21	0 0	12 57.14	9 42.86	0 0	0 0%	—	—
Thinness of rind	21	11 52.38	8 38.10	2 9.52	0 0	0 0%	—	—
Thinness of segment wall	21	21 100.00	0 0	0 0	0 0	0 0%	—	—
Color of pulp	21	21 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	21	0 0	0 0	7 33.33	9 42.86	5 23.81%	—	—
Quantity of pith	21	0 0	0 0	6 28.57	13 61.90	2 9.52%	—	—
Quality of pulp	21	20 95.24	1 4.76	0 0	0 0	0 0%	—	—

rather large, entirely covering the disk, lobes sometimes not well developed. Surface bright-colored, rather even. Oil cell dots more or less large, prominent in several fruits but in others they are distinctly pitted. The appearance is typically Ikeda, judging from the round shape and strongly sinuous stem-end.

Section: Rind uniformly medium-thin to thin, except in a few large fruits. Segments not many, segment wall uniformly very thin, central column small to medium-small, containing little or medium-little amount of pith. Pulp very deep-colored, juicy, quality very uniformly good, sweet and pleasantly acidulous, never insipid, the most desirable quality for storage. Pulp vesicles fine-grained, wall thin, soft. The rind becoming more or less raggy and puffy, but not becoming free from the pulp ball.

The measurements of these fruits are given Table 176.\*

### SHIN NATSUME WASE, MR. NATSUME'S SECOND BUD VARIATION TREE

In November, 1924, Mr. MATSUI of the Mikkabi Agricultural Society sent a note to the writer stating that he had found another bud mutant in Mr. NATSUME's other orchard but he could not obtain any fruit that year for no fruit was borne. As he promised to send in samples of fruit the next year, the writer received 23 fruits in the fall of 1925, which are described later. The plant was visited by the author in April, 1926, and again in October, 1926, and it gave an addition a distinct case of bud variation.

The plant is located in the Borutō Orchard at Nueshiro, Mikkabi-cho, Inasa-gun, Shidzuoka-ken (PL. LII, Fig. 13, and 13<sup>a</sup>). It is on a plateau beyond a water-mill, on the north side of a road, being the 10th tree from the west. The tree has a spread of 1.9 m. in the N-S direction, 2.9 m. in the N-W direction, and a height of 1.5 m. The main trunk of about 17 cm. is slanting toward the south, but the branches arising from the top of the trunk almost at the same place, are turned

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\* PL. XXXIX, Fig. 4.

back to the northward to balance the inclination of the trunk. The Wase branch is on the branch, exactly east starting at about 51 cm. from the ground. The Wase limb runs horizontally for the length of 48 cm. and then forks into two branches measuring 84 cm. and 63 cm. respectively. It is not clear whether the variation covers the whole limb or remains only at the terminal branches above mentioned. The surface of the limb seems to be uniform everywhere except there is an apparent disturbance in growth on the longer branch. The Wase fruits taken in the previous year were collected from the terminal part only, according to Mr. Matsui. At the time of the visit in October, 1926, only one late-bloom, fruit of rounded, conical shape was found. The foliage on the normal part is not very different from that of the other plants of the same orchard as it has large, deep-colored leaves with broad leaf-blades. The leaves on the end of the variation branch are rather fascicled on the short, crowded shoots, are typically twisted, and deep-colored. The whole tree is in a good condition and has a flat, semi-globular head. The tree looks very well cared for, is well fertilized, and is mulched with grasses. The origin of the plant was not told.

The description of the fruits picked in the fall of 1925 is given below :

Fruits large-sized, typical Wase form with low shoulder ; smaller ones tall and not very small in size ; generally roundish in appearance. Apex rounded or slightly concave, rarely convex. Navel present in many fruits. Areola frequently present. Area around the styler point is generally naked, without having oil cell dots. Calyx remarkably large, generally with normal lobes. Disk also very large, usually with distinct margin, occasionally with double ring and mostly accompanied by fine radial striations. Surface is extremely smooth, with large-sized convex oil cell dots ; color still greenish, but the apical half is generally well colored, often being very bright. The outline of the fruit is regular, but in some fruit the rind is raised by the abnormally large-sized segments.

Cross-section : Rind thin, with very rare exceptions. Oil cells not large, inner layer solid and tight. Segment wall comparatively thick.



TABLE 177.

MEASUREMENT OF 23 FRUITS (NOS. 10239-10261) OF SHIN NATSUME WASE,  
FROM MIKKABI SHIDZUOKA PREFECTURE.  
LOT NO. 167 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.44 cm.	5.38 cm.	1.25	123.61 gm.	11.32 mm.	10.70	2.36 mm.	13.83 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	23	—	—	—	—	—	8	23.73%
Sinuate based fruits	23	—	—	—	—	—	1	4.35
Semi-sinuate based fruits	23	—	—	—	—	—	0	0
Areolated fruits	23	—	—	—	—	—	6	26.09
Frs. with undeveloped calyx lobes	22	—	—	—	—	—	2	9.09
Frs. with long narrow calyx lobes	22	—	—	—	—	—	0	0
Fruits containing seeds	23	—	—	—	—	—	0	0
Apical depression	23	0 0	4 17.39	14 60.87	5 21.74%	—	—	—
Apical dots	23	16 69.57	5 21.74	1 8.70%	—	—	—	—
Flatness of fruit	23	0 0	3 13.04	6 26.09	10 43.48	4 17.39%	—	—
Smoothness of fruit	23	10 43.48	12 52.17	1 4.35	0 0	0 0%	—	—
Thinness of rind	23	18 78.26	3 13.04	2 8.70	0 0	0 0%	—	—
Thinness of segment wall	23	0 0	5 21.74	17 73.91	1 4.35	0 0%	—	—
Color of pulp	23	9 39.13	14 60.87	0 0	0 0	0 0%	—	—
Size of central column	23	0 0	7 30.43	12 52.17	3 13.04	1 4.35%	—	—
Quantity of pith	23	0 0	21 91.30	2 8.70	0 0	0 0%	—	—
Quality of pulp	23	3 13.04	2 8.70	12 52.17	6 26.09	0 0%	—	—

Central column medium to medium-large, pith abundant and solid. Pulp solid, juice scanty, three largest fruits taste good but all the rest are deteriorating, and the taste is abnormal. Vesiculation is very coarse, very distinct, solidified, more or less elongated, not typically anastomosing.

The reason why such beautiful-looking fruit has such a deteriorating character inside is not known. The tree seemed not to be overbearing nor in a poor condition but it can be said the condition was unquestionably abnormal in 1925. The quality of the fruit should be tested another year, or fruit from healthy second generation trees examined.

The measurements of these fruits of Shin Natsume Wase are given in Table 177.\*

## NORMAL PART OF THE SHIN NATSUME WASE INDIVIDUAL

The writer received from Mr. MATSUI in November, 1925, 15 fruits borne on the normal part of the Shin Natsume Wase individual. The description of the fruits is given below :

Fruits medium-small, even ranging to small grade, moderately flat, with rather regular equatorial outline. Apex generally broadly depressed, concavity not deep, sometimes slightly reconvexed at the styler point. Oil cell dots generally reaching to the styler point, but sometimes they are absent and the area looks quite naked (No. 10286). Areola is very often conspicuous. Navel present or absent. Base with rather low shoulder, calyx end deeply and acutely sinuate, rarely with grooves (No. 10292). Calyx large, well developed ; disk not enlarged. Surface rather even, only shallowly pitted, often very smooth. Color of surface half green and half yellowish-green, sometimes well colored (No. 10297). Oil cell dots fine and close. General characters agree with Owari, although the fruit is still a little unripe and is not large enough.

Cross-section : The rind is rather thick ; oil cells fairly distinct, about two-fifths of the total thickness ; pith of the rind is rather porous, raggy. Segment wall thin ; central column medium or rather smaller in

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\* Pl. XXXIX, Fig. 4.

TABLE 178.

MEASUREMENT OF 15 FRUITS (NOS. 10283-10297) FROM THE NORMAL PART  
OF THE SHIN NATSUME WASE TREE, MIKKABI, SHIDZUOKA  
PREFECTURE. LOT NO. 171 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.71 cm.	4.48 cm.	1.33	80.11 gm.	11.50 mm.	10.33	3.02 mm.	10.80 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	15	—	—	—	—	—	3	20.00
Sinuate based fruits	15	—	—	—	—	—	6	40.00
Semi-sinuate based fruits	15	—	—	—	—	—	8	53.33
Areolated fruits	15	—	—	—	—	—	9	60.00
Frs. with undeveloped calyx lobes	14	—	—	—	—	—	2	14.28
Frs. with long narrow calyx lobes	14	—	—	—	—	—	0	0
Fruits containing seeds	15	—	—	—	—	—	0	0
Apical depression	15	0 0	8 53.33	6 40.00	1 6.67%	—	—	—
Apical dots	15	1 6.67	4 26.67	10 66.67%	—	—	—	—
Flatness of fruit	15	0 0	7 46.67	7 46.67	1 6.67	0 0%	—	—
Smoothness of fruit	15	2 13.33	3 20.00	7 46.67	3 20.00	0 0%	—	—
Thinness rind	15	1 6.67	1 6.67	6 40.00	7 46.67	0 0%	—	—
Thinness of segment wall	15	9 60.00	6 40.00	0 0	0 0	0 0%	—	—
Color of pulp	15	7 46.67	8 53.33	0 0	0 0	0 0%	—	—
Size of central column	15	0 0	1 6.67	6 40.00	5 33.33	3 20.00%	—	—
Quantity of pith	15	0 0	2 13.33	13 86.67	0 0	0 0%	—	—
Quality of pulp	15	3 20.00	7 46.67	5 33.33	0 0	0 0%	—	—

size, pith rather little in quantity. Segments comparatively few in number, fairly uniform in size. Pulp medium deep-colored, of fairly good quality, though somewhat acidulous, juicy, soft mild, not intensely sweet or acid. Vesiculation fine, indistinct. Even small ones have a quality that is not inferior and the fruit seems to become better in taste when fully mature. The character of this individual very much resembles the normal part of Nagata Wase. The normal part of Suzuki Wase and Fujii Wase, later described, also comes under the same group.

The measurements of these fruits are given in Table 178.\*

### TAKEGAMI WASE, ANOTHER STRAIN OF WASE FROM MIKKABI

In the fall of 1924, the writer was taken by Mr. MATSUI to the orchard of Masaji TAKEGAMI, where he saw a tree which was suspected to be a bud mutating tree. This proved to be true when the author made a critical study (PL. III, Fig. 14, 14<sup>a</sup>, & 15). The tree was also studied in 1915 and 1926.

The orchard is located on a plain near a house and the tree is found in the second southern row, the fifth from the west, just at the east of the path. It is a moderate-sized, unpruned Satsuma of good hemispherical shape, 3.2 m. in N-S spread and 3.5 m. in E-W spread. It has a raised trifoliate stook and a short trunk of 35 cm. in girth. It is divided into two major stems directed east and west, respectively. The western stem runs straight for about 30 cm. and then forks again. A side limb is cast out before reaching this fork, at about 2.3 m. from the ground. This limb immediately sends out a side branch at a wide angle. This side branch runs nearly horizontal for about 66 cm. and then suddenly turns upward, having bushy sprouts at the corner. It again turns down and reaches a point 1.05 m. from the base of the side branch and forks into two, the upper shoots of which are Wase and the lower normal. The bottom of this long side branch presses against the major stem very strongly. The surface of the side branch

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\* PL. XL. Fig. 1.

has a wavy mark about 60 cm. long, which reaches the sporting branch, and the upright part has an especially uneven surface. The tree is said to have been planted about 1908, being a purchased tree from Saitō district in the province of Owari (Aichi Prefecture). The branches look very vigorous, are few in number, long, not crowded, with large, deep-colored, broad, hanging leaves. Autumn shoots are very few in number. These characters agree with Owari, and the character of the leaves of the variation branch does not show any appreciable difference from the other parts. A fruit is left hanging on the variation branch; is a well colored, large, flat example, with large oil cell dots and a considerably large-sized disk, characterizing Wase without doubt. Twelve fruits were counted altogether on the mutation branch at the beginning of the year, but most of them were stolen before reaching full maturity. Five fruits remained in the owner's storehouse and they were all presented to the writer for investigation, together with the one found on the tree.

The tree was heavily pruned in the spring of 1925 and it was showing remarkable vigor in the spring of 1926.

The soil of the orchard is a poor clay with round pebbles, having a depth of 43 cm. Fertilization is practiced by applying a mixture of bean cake, super-phosphate of lime and bone dust. Lime is applied to the plant in a circular ditch during the early spring.

The description of fruits (6 in all) is given below :

Fruits large, typically Wase-like, depressed-globose, rectangular, rather tall; horizontal outline is rather regular, none of them are conical. Apex simply flattened, areola almost none, navel generally large and prominent, with very few dots around the styler point. Base flat, not concave; calyx normal, rather short lobed, lobes being broad-triangular and thick. The disk is very characteristic, being very large and the margin is quite confluent with the bordering rind without showing a definite demarcation. Radial striations present. Surface even, no fovea, at least part is bright-colored; oil cell dots far apart, large and smooth. Infected with the sour scab, which somewhat spoils the looks of the fruit.

Cross-section: Rind thin (not very thin), oil cells medium-large, segment wall medium in thickness. Central column more or less small,

TABLE 179.

MEASUREMENT OF 6 FRUITS (NOS. 9166-9170, 9589) OF THE TAKEGAMI  
WASE, FROM MIKKABI SHIDZUOKA PREFECTURE.  
LOT NO. 139 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.20 cm.	5.12 cm.	1.38	160.33 gm.	10.50 mm.	11.17	2.75 mm.	12.42 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	6	—	—	—	—	—	3	50.00
Sinuate based fruits	6	—	—	—	—	—	0	0
Semi-sinuate based fruits	6	—	—	—	—	—	0	0
Areolated fruits	6	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	6	—	—	—	—	—	1	16.67
Frs. with long narrow calyx lobes	6	—	—	—	—	—	0	0
Fruits containing seeds	6	—	—	—	—	—	0	0
Apical depression	6	0 0	1 16.67	3 50.00	2 33.33%	—	—	—
Apical dots	6	0 0	6 100.00	0 0%	—	—	—	—
Flatness of fruit	6	2 33.33	2 33.33	2 33.33	0 0	0 0%	—	—
Smoothness of fruit	6	1 16.67	5 83.33	0 0	0 0	0 0%	—	—
Thinness of rind	6	2 33.33	4 66.66	0 0	0 0	0 0%	—	—
Thinness of segment wall	6	1 16.67	1 16.67	4 66.67	0 0	0 0%	—	—
Color of pulp	6	5 83.33	1 16.67	0 0	0 0	0 0%	—	—
Size of central column	6	0 0	0 0	2 33.33	2 33.33	2 33.33%	—	—
Quantity of pith	6	0 0	4 66.67	2 33.33	0 0	0 0%	—	—
Quality of pulp	5	3 60.00	2 40.00	0 0	0 0	0 0%	—	—

with abundant quantity of pith. In the last picked fruit (No. 9889), both rind and wall are thin. Segments rarely very irregular (No. 9170), but generally fairly regular. Pulp deep-colored, juicy, never dried quality varying from good to medium-good, often excellent (No. 9889), sometimes more or less insipid. Vesicles large, coarsely reticulate, but not extremely large. General conclusion is to rank the fruit with the Kawano Wase in appearance and quality; it is slightly better than the Nagata Wase.

The measurements of these fruits are given in Table 179.\*

Two fruits (Nos. 10276-10277) were received in 1925. They are described below :

Fruits medium-large, rather tall, heavy. Apex simply shallowly concave, area surrounding the styler point is almost naked, though a few dots are present. Areola and navel not developed. Base has low shoulder; calyx end is somewhat crater-like, but not sinuous and only shallowly concave. Calyx large, flat, lobes normal, well developed. Disk large, prominent, but demarcation is rather clear this year, fine radial striations running out from it. Surface smooth, half light green, half orange-colored, but not bright-colored as yet. Oil cell dots large, conspicuous, all convex but not rough. Skin tight and the horizontal outline is more or less irregular. The second fruit is onesided, half of the fruit not being fully developed.

Cross-section : Rind rather thin, texture solid, oil cell dots sparse, distinct. Wall medium in thickness; central column medium-sized, with pith medium-much in quantity. Segment rather uniform in size. Pulp beautifully colored, fleshy, of fairly good quality, sweetness not insufficient, slightly acidulous, somewhat hardened. Vesiculation distinct, large-grained, crisp but not dry, containing a sufficient amount of juice.

The above description is summarized in Table 180.\*\*

In 1926, 11 fruits of the Takegami Wase were received from Mr. MATSUI of Mikkabi. These are described as follows :

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\* PL. XL, Fig. 2.

\*\* PL. XL, Fig. 3.

TABLE 180.

MEASUREMENT OF 2 FRUITS (NOS. 10276-10277) OF TAKEGAMI WASE,  
FROM MIKKABI SHIDZUOKA PREFECTURE.

LOT NO. 169 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.30 cm.	5.70 cm.	1.27	138.00 gm.	12.00 mm.	10.50	2.62 mm.	15.15 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	2	—	—	—	—	—	0	% 0
Sinuate based fruits	2	—	—	—	—	—	0	0
Semi-sinuate based fruits	2	—	—	—	—	—	0	0
Areolated fruits	2	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	2	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	2	—	—	—	—	—	0	0
Fruits containing seeds	2	—	—	—	—	—	0	0
Apical depression	2	0 0	0 0	1 50.00	1 50.00%	—	—	—
Apical dots	2	0 0	2 100.00	0 0%	—	—	—	—
Flatness of fruit	2	0 0	0 0	0 0	2 100.00	0 0%	—	—
Smoothness of fruit	2	0 0	2 100.00	0 0	0 0	0 0%	—	—
Thinness of rind	2	2 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	2	0 0	0 0	2 100.00	0 0	0 0%	—	—
Color of pulp	2	2 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	2	0 0	0 0	2 100.00	0 0	0 0%	—	—
Quantity of pith	2	0 0	2 100.00	0 0	0 0	0 0%	—	—
Quality of pulp	2	2 100.00	0 0	0 0	0 0	0 0%	—	—



TABLE 181.

MEASUREMENT OF 11 FRUITS (NOS. 10757-10767) OF TAKEGAMI WASE,  
FROM MIKKABI SHIDZUOKA PREFECTURE.  
LOT NO. 191 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.42 cm.	5.11 cm.	1.27	113.36 gm.	12.18 mm.	10.27	2.39 mm.	10.17 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	11	—	—	—	—	—	1	% 9.09
Sinuate based fruits	11	—	—	—	—	—	0	0
Semi-sinuate based fruits	11	—	—	—	—	—	0	0
Areolated fruits	11	—	—	—	—	—	2	18.18
Frs. with undeveloped calyx lobes	11	—	—	—	—	—	1	9.09
Frs. with long narrow calyx lobes	11	—	—	—	—	—	1	9.09
Fruits containing seeds	11	—	—	—	—	—	0	0
Apical depression	11	0 0	0 0	8 72.73	3 27.27%	—	—	—
Apical dots	11	2 18.18	4 36.36	5 45.45%	—	—	—	—
Flatness of fruit	11	0 0	3 27.27	4 36.36	4 36.36	0 0%	—	—
Smoothness of fruit	11	8 72.72	3 27.27	0 0	0 0	0 0%	—	—
Thinness of rind	11	11 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	11	4 36.36	5 45.45	2 18.18	0 0	0 0%	—	—
Color of pulp	11	11 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	11	0 0	0 0	1 9.09	5 45.45	5 45.45%	—	—
Quantity of pith	11	0 0	0 0	11 100.00	0 0	0 0%	—	—
Quality of pulp	11	11 100.00	0 0	0 0	0 0	0 0%	—	—

Fruits large, medium-large ones predominate, none in small grade. Shape rather roundish, globose to depressed globose, ranging from medium-flat to medium-high. Horizontal outline is somewhat irregular, due to the presence of irregular, large-sized segments. Apex flat, in many cases dots reaching to the styler point; naked area small, if present. Areola rarely present; navel rarely open. Base all flat, never sinuous, very shallowly concave. Calyx large, normal, well lobed. Disk large, margin generally clear and rarely double ringed (No. 10759), surface around the disk is slightly naked. Surface beautifully colored, even, oil cell dots very large, convex. The appearance of the whole fruit is very like Kawano Wase.

Section: Rind uniformly thin, rather adherent to the pulp ball, rather strong in texture. Segment wall medium-thin, white, but never becoming very thick. Central column small to medium, with not much pith. Segments rather few in number, size often very irregular, rarely containing vary large segment (one segment in fruit No. 10701 measures 3 mm. in diameter at the outer end, tangential to the outer curvature). Pulp very deep-colored, uniformly very meaty, not white nor dried, excellently in taste, quality of all good throughout the lot. It appears that the flavor changes very little during long storage. Some fruits were excellent to the taste on December 20, so that the quality keeps much better than in Kawano Wase. The general characters are almost similar to it in the cross-section.

The measurements of these fruits are given in Table 181.\*

### FRUITS FROM THE NORMAL PART OF THE TAKEGAMI WASE

The fruits from the normal part of the bud variation tree, Takegami Wase, at Mikkabi were first studied in 1924. The following description was given to 17 fruits received.

Fruits uniformly medium-large, typically depressed globose, regular in outline, simply and gradually flattened at both ends. Apex flattened

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\* PL. XL, Fig. 4.

or slightly depressed, rarely broadly shallow-concave, areolate, dots reaching to the stylar point. Navel generally closed. Base flattened, shallowly concave toward the stem-end and more or less abruptly sinuate after reaching the calyx. Calyx large, well lobed, nearly always accompanied by radial striations as in Wase fruit (but not fine as in the common Wase fruits). Disk occasionally more or less enlarged, sometimes surrounded by a double ring. Surface bright-colored, evenly roughened by convex oil cell dots and shallow fovea, not strongly pitted throughout. Oil cell dots rather prominent, but smaller in size than in Wase.

Cross-section: Rind more or less thick, adherent, rarely more or less loose, elastic, not brittle. Segment wall thick, tends to become thinner, translucent inner part thicker, the pith of the center not penetrating. Central column notably small and with more or less abundant quantity of pith. Pulp intensely colored, of good quality, juicy, soft, not variable. Pulp vesicles fine-grained. Every character agrees with that of Owari.

The measurements of these fruits are given in Table 182.\*

In the following season, 1925, the crop was very poor, but 5 fruits were sent in by Mr. MATSUI. The brief description of these fruits is given below:

Fruits small-sized, moderately flattened (very round in No. 10282), shoulder low, horizontal outline regular, Compact and heavy. Apex shallowly depressed (only flat in No. 10282), dots present up to the stylar point. Navel closed, areola not developed, only showing a mark in the large fruits. Base sinuous, disk not enlarged; calyx normal, lobes well developed. The area around the calyx lacks radial striations. Surface deep green when tested (Nov. 28, 1925), only small area turning yellow. Oil cell dots fine and close, pitting rather conspicuously foveolate. Rather poor-looking fruits for an Owari.

Cross-section: Rind medium to medium-thin; oil cells rather large, close, distinct, irregular in distribution, pith of the rind more or less colored, solid. Segment wall rather thick, central column small and

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\* PL. XL, Fig. 5.

TABLE 182.

MEASUREMENT OF 17 OWARI FRUITS (NOS. 9890-9906) FROM TAKEGAMI'S BUD  
VARIATION TREE, AT MIKKABI, SHIDZUOKA PREFECTURE.  
LOT NO. 158 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.15 cm.	5.11 cm.	1.38	128.82 gm.	10.94 mm.	10.88	3.31 mm.	10.65 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	17	—	—	—	—	1	% 5.88
Sinuate based fruits	17	—	—	—	—	5	29.41
Semi-sinuate based fruits	17	—	—	—	—	10	58.82
Areolated fruits	17	—	—	—	—	9	52.94
Frs. with undeveloped calyx lobes	17	—	—	—	—	0	0
Frs. with long narrow calyx lobes	17	—	—	—	—	0	0
Fruits containing seeds	17	—	—	—	—	0	0
Apical depression	17	0 0	7 41.17	6 35.29	4 23.53%	—	—
Apical dots	17	0 0	1 5.88	16 94.12%	—	—	—
Flatness of fruit	17	1 5.88	11 64.71	5 29.41	0 0	0 0%	—
Smoothness of fruit	17	0 0	0 0	17 100.00	0 0	0 0%	—
Thinness of rind	17	0 0	7 41.17	10 58.82	0 0	0 0%	—
Thinness of segment wall	17	6 35.29	7 41.17	4 23.53	0 0	0 0%	—
Color of pulp	17	17 100.00	0 0	0 0	0 0	0 0%	—
Size of central column	17	0 0	0 0	1 5.88	9 52.94	7 41.17%	—
Quantity of pith	17	1 5.88	7 41.17	9 52.94	0 0	0 0%	—
Quality of pulp	17	17 100.00	0 0	0 0	0 0	0 0%	—

TABLE 183.

MEASUREMENT OF 5 FRUITS (NOS. 10278-10282) FROM NORMAL PART OF  
TAKEGAMI'S BUD VARIATION TREE, AT MIKKABI, SHIDZUOKA  
PREFECTURE. LOT NO. 170 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.58 cm.	4.56 cm.	1.30	84.60 gm.	11.60 mm.	10.60	2.60 mm.	9.10 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	5	—	—	—	—	—	0	% 0
Sinuate based fruits	5	—	—	—	—	—	4	80.00
Semi-sinuate based fruits	5	—	—	—	—	—	0	0
Areolated fruits	5	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	5	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	5	—	—	—	—	—	0	0
Fruits containing seeds	5	—	—	—	—	—	1	20.00
Apical depression	5	0 0	0 0	3 60.00	2 40.00%	—	—	—
Apical dots	5	0 0	0 0	5 100.00%	—	—	—	—
Flatness of fruit	5	0 0	0 0	4 80.00	0 0	1 20.00%	—	—
Smoothness of fruit	5	0 0	0 0	5 100.00	0 0	0 0%	—	—
Thinness of rind	5	0 0	4 80.00	1 20.00	0 0	0 0%	—	—
Thinness of segment wall	5	1 20.00	1 20.00	3 60.00	0 0	0 0%	—	—
Color of pulp	5	2 40.00	2 40.00	1 20.00	0 0	0 0%	—	—
Size of central column	5	0 0	0 0	1 20.00	3 60.00	1 20.00%	—	—
Quantity of pith	5	2 40.00	3 60.00	0 0	0 0	0 0%	—	—
Quality of pulp	5	1 20.00	4 80.00	0 0	0 0	0 0%	—	—

pithy. Pulp meaty, hard, more or less deep-colored when examined (December 4), and flavor generally medium-good with more or less strong acidity. Vesicles rather coarse, distinct.

In comparison with Wase fruits borne on the same tree, the contrast is very great. In Wase, the flavor is very much better and the vesicles are large and few in number.

The measurements of these fruits are given in Table 183.\*

The fruits from the normal part of the Takegami Wase plant were examined for the third time in the fall of 1926; the description is given below :

Fruit small, more or less roundish, depressed globose, all resembling Wase, except No. 10753, which is decidedly the Owari type. This fruit (No. 10753) is medium-high, distinctly pitted, sinuate around the calyx, with broadly concave apex and dotted styler area. The rest of the fruits are smooth; apex rather broadly, but not deeply, concave, dots reaching to the styler point, navel closed. Base rather flattened, smooth; calyx large (smaller than in Wase) and lobes thick, generally covering the disk, except No. 10752, in which the enlarged disk has a indistinct margin. Surface smooth with more or less large dots. These smooth fruits resemble very much Wase fruits (but the difference is clear in the cross-section described below.)

Cross-section: No. 10753 has thick skin, very few segments, small central column, and large but elongated pulp vesicles. The rest have thin rind, thin wall, more or less small central column with rather small amount of pith. Pulp of these fruits is deep-colored, of fairly good quality, but was slightly over-ripe when tasted (December 21st). Vesiculation not very fine, but fairly finely netted. The general character is not very desirable, and the fruit is perhaps ordinary Owari of no special merit. The character of these fruits seems best marked in the crop of 1924, and the crops of the succeeding years seem to be rather abnormal.

The measurements of these fruits are given in Table 184.\*\*

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\* PL. XLI, Fig. 1.

\*\* PL. XLI, Fig. 2.

TABLE 184.

MEASUREMENT OF 5 FRUITS (NOS. 10752-10756) FROM THE NORMAL PART  
OF TAKEGAMI'S BUD VARIATION TREE, AT MIKABI, SHIDZUOKA  
PREFECTURE. LOT NO. 190 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.40 cm.	4.10 cm.	1.35	66.40 gm.	10.60 mm.	10.00	2.25 mm.	10.50 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	5	—	—	—	—	—	0	% 0
Sinuate based fruits	5	—	—	—	—	—	2	40.00
Semi-sinuate based fruits	5	—	—	—	—	—	0	0
Areolated fruits	5	—	—	—	—	—	1	20.00
Frs. with undeveloped calyx lobes	5	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	5	—	—	—	—	—	0	0
Fruits containing seeds	5	—	—	—	—	—	0	0
Apical depression	5	0 0	0 0	5 100.00	0 0%	—	—	—
Apical dots	5	0 0	3 60.00	2 40.00%	—	—	—	—
Flatness of fruit	5	0 0	4 80.00	1 20.00	0 0	0 0%	—	—
Smoothness of fruit	5	4 80.00	0 0	1 20.00	0 0	0 0%	—	—
Thinness of rind	5	4 80.00	0 0	1 20.00	0 0	0 0%	—	—
Thinness of segment wall	5	4 80.00	0 0	1 20.00	0 0	0 0%	—	—
Color of pulp	5	5 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	5	0 0	0 0	4 80.00	1 20.00	0 0%	—	—
Quantity of pith	5	0 0	0 0	5 100.00	0 0	0 0%	—	—
Quality of pulp	5	1 20.00	3 60.00	1 20.00	0 0	0 0%	—	—

## **BOOK VIII**





## STUDIES IN THE BUD VARIATION OF THE SATSUMA ORANGE

### *III. The Third Period of Discovery*

#### **SUZUKI WASE, A NEW BUD VARIATION WASE FROM MIKKABI**

During the course of endless discoveries of new bud variation strains of the Wase Satsuma orange at Mikkabi, due to the activity of Mr. Ken'itsu MATSUI, this new strain came to the author's attention in the fall of 1925.

The plant is located in the orchard of Ginjirô SUZUKI, at Akazari, Hirayama, Mikkabi-chô, Inasa-gun, Shidzuoka-ken (PL. LIII, Fig. 1). The orchard is nearly flat, being only slightly inclined toward the east, and the plant is the third, east of a bush of Kinokuni. It is a tree about 23 years old, having a diameter of 2.6 m. in both E-W and N-S spread, and a height of 1.7 m. It is rather upright in habit, with a short trunk and an enormously enlarged trifoliate root-stock, also with three low branching, slender major stems and one upright stem facing the south. The variation branch starts on this upright stem at 1.08 m. from the ground. The variation branch runs toward the east, having a length of about 75 cm. This branch has a considerably thickened part at about 30 cm. from the bottom, and many bushy shoots arise from this swollen part. The terminal part of this branch is arched and has a bushy shoot with small, light-colored leaves. One of the shoots coming from the swollen part has a thorn measuring about 1 cm. The leaves on the other parts are large, hanging, almost typical of the Owari variety. The whole tree looks rather poor in condition, and perhaps it was defoliated in the preceding spring due to an attack of cold wind. The soil is red clay, looking fertile, but shallow (15-17 cm. deep). Fertilization constitutes of a mixed dose of dried herring, soy bean cake

and super-phosphate of lime, the total amount being 3 sho (5.5 litres) per tree. The owner of the tree states that the nursery plant came from Kira, Hekikai-gun, Aichi Prefecture. The bud variation was found by him at least 7 years ago, but he knew that such a variation is not limited to his plant but is also found in other orchards, for instance, there is one in an orchard owned by Chûhei MORITA.\* He also stated that the fruit on the mutation branch matures about 20 days earlier than the rest, and these fruits are distinguished by their large size and by a habit of being borne in heavy clusters.

Second generation trees from this branch were also found in the garden of Etsuji SUZUKI. They were 3 years old in 1926. It is said that one of these plants bore fruits as early as 1925. These plants looked typical of Wase but one of them was found to bear thorns on its stronger shoots.

The description of Wase fruits received in 1925 and taken from the original Suzuki Wase, tree is given below :

Fruit looks almost similar to Aoe Wase ; is large-sized, roundish, rectangular, rather tall but sometimes quite flat without much depression at both ends. Horizontal outline regular, shoulder low ; apex flattened, often convex, depression, if present, only very shallow, areola not prominent, naked area around the styler point is not conspicuous ; navel prominent. Base flattened ; calyx large and conspicuous, sometimes with craw-like, elongated lobes. Disk very prominent, large, demarcation indistinct, the surrounding area has fine radial striations ; double ring rarely present. Surface bright-colored, very smooth, with very conspicuous large-sized oil cell dots which are sometimes magnificent, measuring about 1.5 mm. in diameter, and often very convex, giving shark-skin-like convexities appearing very rough ; no fovea exists. This is the most typical Wase, close to Kawano Wase, of very desirable size and appearance.

Cross-section : Rind generally thin, especially in the smaller half of the whole lot, texture elastic, leathery, inner layer solid but not brittle, oil cells rather far apart, in larger fruits they occupy about  $\frac{1}{3}$ – $\frac{1}{2}$  of the total thickness. Segments not few, fairly uniform in shape ; wall thin,

\* Its bud variation is described later on.

slightly thicker in larger fruits but very thin in smaller ones. Central column medium-sized, rather large in the larger members, small in smaller members, pith not solid, rather cottony. Pulp remarkably deep-colored and juicy, exceedingly rich in flavor, sweet enough and very palatable. Vesiculation typically coarse in larger fruits, somewhat fine in smaller ones, never distinct and rough looking.

This is certainly a remarkable feature among Wase fruits, almost matching or better than MATSUO's Nakashima strain of the Owari variety, and also better than Sueoka Wase. Perhaps this is best of all the Mikkabi series of bud variation Wase Satsumas.

The measurements of these fruits are given in Table 185.\*

This variation branch did not bear fruits in 1926.

### NORMAL PART OF THE SUZUKI WASE PLANT AT MIKKABI

Sixteen fruits from the normal part of a Suzuki Wase plant came to the author's attention in November, 1925. The following description is given about these fruits:

Fruits rather large, grading toward moderately small size (never too small), flat, not tall, horizontal outline uniform without longitudinal furrows. Apex moderately broad-concave, never too deep; dots generally reaching to the styler point; areola prevailing slightly, navel closed. Base shallowly depressed, not typically sinuate, with no radiating grooves but more or less finely striated, often having double rings. Calyx medium in size, rather irregular, lobes not well developed. Disk often more or less enlarged (Nos. 10513, 10515), demarcation becoming slightly faint. Surface semi-bright-colored and partly green, dull and not shiny, slightly even or pitted, sometimes smooth, never very rough; oil cell dots slightly convex or foveolate, small, close, not distinct.

Cross-section: Rind rather thick, oil cells medium-sized, fairly distinct, close, about  $\frac{1}{3}$ – $\frac{2}{5}$  of the whole thickness, inner layer rather thick and less raggy. Segments moderately many, rather regular; wall not

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\* PL. XLI, Fig. 3.

TABLE 185.

MEASUREMENT OF 35 FRUITS (NOS. 10478-10512) OF THE SUZUKI WASE,  
FROM ORIGINAL TREE AT MIKKABI INASA-GUN, SHIDZUOKA  
PREFECTURE. LOT NO. 176 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.12 cm.	4.79 cm.	1.34	102.71 gm.	11.77 mm.	10.86	2.26 mm.	12.89 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	35	—	—	—	—	—	19	54.29%
Sinuate based fruits	35	—	—	—	—	—	0	0
Semi-sinuate based fruits	35	—	—	—	—	—	0	0
Areolated fruits	35	—	—	—	—	—	1	2.86
Frs. with undeveloped calyx lobes	35	—	—	—	—	—	2	5.71
Frs. with long narrow calyx lobes	35	—	—	—	—	—	1	2.86
Fruits containing seeds	35	—	—	—	—	—	1	2.86
Apical depression	35	0 0	1 2.86	14 40.00	20 57.14%	—	—	—
Apical dots	35	0 0	11 31.43	24 68.57%	—	—	—	—
Flatness of fruit	35	0 0	9 25.71	15 42.86	11 31.43	0 0%	—	—
Smoothness of fruit	35	13 37.14	22 62.86	0 0	0 0	0 0%	—	—
Thinness of rind	35	29 82.86	5 14.29	1 2.86	0 0	0 0%	—	—
Thinness of segment wall	35	25 71.43	5 14.29	5 14.29	0 0	0 0%	—	—
Color of pulp	35	34 97.14	1 2.86	0 0	0 0	0 0%	—	—
Size of central column	35	0 0	6 17.14	22 62.86	6 17.14	1 2.86%	—	—
Quantity of pith	35	0 0	7 20.00	27 77.14	1 2.86	0 0%	—	—
Quality of pulp	35	29 82.86	6 17.14	0 0	0 0	0 0%	—	—

TABLE 186.

MEASUREMENT OF 16 OWARI FRUITS (NOS. 10513-10528) FROM THE NORMAL  
PART OF THE SUZUKI WASE ORIGINAL TREE IN SHIDZUOKA  
PREFECTURE. LOT NO. 177 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.17 cm.	4.39 cm.	1.40	85.56 gm.	10.25 mm.	10.94	2.48 mm.	11.53 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	16	—	—	—	—	—	0	% 0
Sinuate based fruits	16	—	—	—	—	—	3	18.75
Semi-sinuate based fruits	16	—	—	—	—	—	0	0
Areolated fruits	16	—	—	—	—	—	6	37.50
Frs. with undeveloped calyx lobes	16	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	16	—	—	—	—	—	0	0
Fruits containing seeds	16	—	—	—	—	—	1	6.25
Apical depression	16	0 0	3 18.75	13 81.25	0 0%	—	—	—
Apical dots	16	0 0	2 12.50	14 87.50%	—	—	—	—
Flatness of fruit	16	6 37.50	7 43.75	3 18.75	0 0	0 0%	—	—
Smoothness of fruit	16	0 0	3 18.75	10 62.50	3 18.75	0 0%	—	—
Thinness of rind	16	0 0	4 25.00	7 43.75	5 31.25	0 0%	—	—
Thinness of segment wall	16	8 50.00	8 60.00	0 0	0 0	0 0%	—	—
Color of pulp	16	14 87.50	2 12.50	0 0	0 0	0 0%	—	—
Size of central column	16	0 0	1 6.25	11 68.75	4 25.00	0 0%	—	—
Quantity of pith	16	0 0	3 18.75	12 75.00	1 6.25	0 0%	—	—
Quality of pulp	16	3 18.75	5 31.25	6 37.50	2 12.50	0 0%	—	—

very thin. Central column rather large, and pith fairly abundant, solid if there is a small quantity. Pulp uniformly deep-colored, soft, juicy, of moderately good quality, sometimes slightly acidulous. Vesicles indistinct, rather elongated and not reticulate. This is unquestionably an Owari of good quality, but not so excellent as some select strains.

The measurements of these fruits are given in Table 186.\*

### FUJII WASE ANOTHER NEW WASE STRAIN FROM MIKKABI

This is another Wase strain which originated through a bud variation and was found at Mikkabi through the effort of Mr. MATSUI. The plant was visited by the author in April and October of 1926 and the study of the fruit was made in the years 1925 and 1926.

The tree is located in the orchard of Kakubei FUJII, at Ushi, Mikkabi-chô, Inasa-gun, Shidzuoka-ken (PL. LIII, Fig. 2). The orchard is on a small hill sloping gradually toward the north-east, just above a mulberry field. The plant is the fourth tree in the north row from a ditch, counted upward from the mulberry below, being a slender, unpruned individual of about 15 years of age, about 1.7 m. in spread. The base of the tree has a swollen trifoliate root exposed above the ground and the stem is divided into three major branches at the bottom. The tallest branch runs east-ward, and after passing a part of considerable branching at about midway, turns abruptly in a horizontal direction at about 81 cm. from the ground. This horizontal branch extends about 96 cm., having a more or less uneven surface at the back. This is the limb which bears Wase fruits. The tree did not look very healthy in April and the leaves were considerably yellowish and somewhat contorted and upright, perhaps due to passing a severe winter the previous year. The foliage of the variation part was not considerably different but it looked still lighter in color than that of the other parts. In October, the plant looked more vigorous and the variation branch appeared distinct from the other parts

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\* PL. XLI, Fig. 4.

by having lighter colored, more or less crowded and more contorted leaves. It was also noticed that the fruits on the limb were colored far in advance and were much brighter than those on the other part. The fruit on the normal branches looked smaller, more green, and very pitted.

The crop of this limb, studied in the fall of 1925, is described below :

Fruits medium to small, very regular in outline, rather flat, shoulder low. Apex flat or slightly concave, oil cell dots often naked around the stylar point, sometimes quite naked. Areola present but not conspicuous. Navel only rarely open. Base slightly depressed, without conspicuous furrows or striations but generally smooth. Calyx normal, not large, often with undeveloped lobes, more or less high. Disk normal, round, elevated, some-times with small double ring, but margin always clear. Surface smooth, showing well the Wase characters, having almost no fovea, beautifully colored. Oil cell dots large, prominent, smooth or convex. Although stem-end characters are not so fully developed as in Wase, the shape, the texture of rind, oil cell dots, coloring, apical characters, all agree with Wase. The small size and flatness of the fruit are perhaps due to over-bearing.

Cross-section : Rind thin, very uniform in thickness. Segments rather regular, not many in number, a number of fruits containing only 8 segments and only a few of them having 11. Segment wall medium-thin, central column rather small, quantity of pith rather abundant. Pulp deep-colored, sweet and mildly acidulous, of good quality, not insipid. Vesiculation coarse, not solidifying nor whitening. Generally desirable characters with excellent quality of pulp.

The measurements of these fruits are given in Table 187.\*

The fruits of Fujii Wase were received again in the fall of 1926, and were re-described as follows :

One fruit (No. 10675) large, the rest medium-small in size. The large fruit is depressed globose, ends simply flat, apex with naked area and open navel ; base with double ring, large disk with faint margin, and



radial striations, all typical of Wase. All small members uniform in size, depressed globose; apex only slightly concave or flat, some not having naked apex; navel generally closed, and areola only rarely present. Base usually not concave, often double-ringed; calyx small, not well lobed. Disk not conspicuously enlarged. Surface generally not good-colored, some partly greenish, generally even; oil cell dots large, sometimes very conspicuous. Infected with sour scab.

Cross-section: Rind thin (hard in scab-infected fruits), in larger fruits rather variable in thickness, fairly dense in texture, oil cells medium-large. Wall rather thin, segments few and irregular, more uniform in large fruit. Central column rather small, pith not abundant. Pulp deep-colored, but some discolored from storing until Jan. 11, 1927, of fairly good quality, not becoming insipid. Vesiculation reticulate, rather coarse but vesicles have thin wall, never hardened. General qualification is not so good as it was the year before, perhaps due to the poor condition of the tree as stated before. Fifteen fruits were sent as Fujii Wase, but under close examination, 4 were discarded and added to Owari, because of the distinct Owari characters of pitted oil cell dots and fine, elongated vesiculation. The measurements of the remaining 11 fruits are given in Table 188.\*

### NORMAL FRUITS FROM FUJII'S BUD VARIATION TREE

Fruits from the normal part of Kakubei FUJII's bud variation tree were received for study in 1925 and 1926 from Mr. MATSUI. The following is a description given for the crop of 1925, which came from a representative branch.

Fruits medium-small, ranging to small; outline rather uniform, oblate, none of them tall nor conical. Apex flat or shallowly concave, dots either reaching to the styler point or the area left naked. Areola sometimes present; navel exceptionally developed. Base only slightly depressed, not conspicuously sinuous; calyx small, the development of lobes often imperfect but the calyx body not swollen up. Disk never

\* PL. XLI, Fig. 6.

TABLE 187.

MEASUREMENT OF 58 FRUITS (NOS. 10298-10354, 10477) OF FUJII WASE  
FROM MIKKABI, SHIDZUOKA PREFECTURE. LOT NO. 172 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.56 cm.	4.41 cm.	1.35	80.48 gm.	9.48 mm.	9.66	2.37 mm.	10.96 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	58	—	—	—	—	3	% 0
Sinuate based fruits	58	—	—	—	—	11	18.97
Semi-sinuate based fruits	58	—	—	—	—	0	0
Areolated fruits	58	—	—	—	—	29	50.00
Frs. with undeveloped calyx lobes	58	—	—	—	—	21	36.21
Frs. with long narrow calyx lobes	58	—	—	—	—	0	0
Fruits containing seeds	58	—	—	—	—	0	0
Apical depression	58	0 0	2 3.45	45 77.59	11 18.96%	—	—
Apical dots	58	27 46.55	21 36.21	10 17.24%	—	—	—
Flatness of fruit	58	16 27.59	21 36.21	13 22.41	7 12.07	1 1.72%	—
Smoothness of fruit	58	21 36.21	36 62.07	1 1.72	0 0	0 0%	—
Thinness of rind	58	41 70.69	17 29.31	0 0	0 0	0 0%	—
Thinness of segment wall	58	24 41.38	31 53.45	3 5.17	0 0	0 0%	—
Color of pulp	58	53 91.38	5 8.62	0 0	0 0	0 0%	—
Size of central column	58	0 0	3 5.17	33 56.90	17 29.31	5 8.62%	—
Quantity of pith	58	0 0	17 29.31	35 60.34	6 10.34	0 0%	—
Quality of pulp	58	47 81.03	11 18.97	0 0	0 0	0 0%	—

TABLE 188.

MEASUREMENT OF 11 FRUITS (NOS. 10674-10688, EXCL. 10678, 10682, 10685, & 10687) OF FUJII WASE FROM MIKKABI, SHIDZUOKA  
PREFECTURE. LOT NO. 182 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.69 cm.	4.69 cm.	1.34	98.19	9.73 mm.	9.91	2.84 mm.	12.00 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	11	—	—	—	—	—	1	% 9.09
Sinuate based fruits	11	—	—	—	—	—	0	0
Semi-sinuate based fruits	11	—	—	—	—	—	1	9.09
Areolated fruits	11	—	—	—	—	—	3	27.27
Frs. with undeveloped calyx lobes	11	—	—	—	—	—	3	27.27
Frs. with long narrow calyx lobes	11	—	—	—	—	—	0	0
Fruits containing seeds	11	—	—	—	—	—	1	9.05
Apical depression	11	0 0	0 0	10 90.91	1 9.09%	—	—	—
Apical dots	11	2 18.18	8 72.73	1 9.09%	—	—	—	—
Flatness of fruit	11	0 0	1 9.09	9 81.82	1 9.09	0 0%	—	—
Smoothness of fruit	11	0 0	10 90.91	1 9.09	0 0	0 0%	—	—
Thinness of rind	11	4 36.36	4 36.36	3 27.27	0 0	0 0%	—	—
Thinness of segment wall	11	6 54.55	4 36.36	1 9.09	0 0	0 0%	—	—
Color of pulp	11	7 63.64	4 36.36	0 0	0 0	0 0%	—	—
Size of central column	11	0 0	0 0	9 81.82	2 18.18	0 0%	—	—
Quantity of pith	11	0 0	2 18.18	9 81.82	0 0	0 0%	—	—
Quality of pulp	11	9 81.82	2 18.18	0 0	0 0	0 0%	—	—

enlarged. Surface rather smooth, glazed, oil cell dots rather conspicuous, fine, more or less far apart, even, slightly convex or concave, not conspicuously pitting, generally almost as smooth as in Wase. Color yellow over one-half of the total area of the surface, but not so bright as in Wase. In comparison with the Fujii Wase fruits, the oil cell dots are nearly  $\frac{2}{3}$  in size, the basal depression is a little deeper, the color is not so bright or shiny, etc. Distinctly is an Owari of no special value.

Cross-section: Rind thin, or very thin in smaller fruits, oil cells minute and not very distinct. Segment wall thin, central column small, with medium quantity of pith. Pulp juicy, intensely colored and acidulous. Vesiculation almost indistinct, very fine-grained. It is unquestionably an Owari in every respect. In comparing with the Fujii Wase fruits, a great difference is noticed in the maturity of the pulp, but the oil cells, the color of the pulp, the size of the vesicles, and the thinness of the rind are almost similar. In Wase fruits, the vesiculation is slightly coarser and more reticulate, the segment wall thicker, and the central column has more pith.

The measurements of these fruits are given in Table 189.\*

Fruits from the normal part of the Fujii Wase were received again in the fall of 1926. There were only 5 of these, but 4 fruits discarded from the Wase lot were added so a total of 9 fruits constitutes this lot. A description of these fruits is given as follows:

Fruits ranging from medium-small to small, roundish and slightly depressed, ends rounded; apex only slightly concave, area around the stylar point either dotted or naked. Areola rarely present. Navels all closed. Base not concave, never sinuate; calyx small, lobes not well developed; disk large, rather conspicuous. Surface smooth, more or less greenish, not well colored, oil cell dots not conspicuously large as in Wase fruits; scabby and russet.

Cross-section: Rind thin, dense in texture, solid, leathery, thickness uniform, oil cells very fine. Segments few in number, wall thin to

\* PL. XLII, Fig. 1.

TABLE 189.

MEASUREMENT OF 17 FRUITS (NOS. 10355-10371) FROM A NORMAL BRANCH  
OF THE FUJII WASE TREE FROM MIKKABI, SHIDZUOKA  
PREFECTURE. LOT NO. 173 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.33 cm.	3.98 cm.	1.40	65.30 gm.	9.81 mm.	10.41	2.03 mm.	10.03 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	17	—	—	—	—	—	1	5.88
Sinuate based fruits	17	—	—	—	—	—	0	0
Semi-sinuate based fruits	17	—	—	—	—	—	0	0
Areolated fruits	17	—	—	—	—	—	12	70.59
Frs. with undeveloped calyx lobes	17	—	—	—	—	—	2	11.76
Frs. with long narrow calyx lobes	17	—	—	—	—	—	0	0
Fruits containing seeds	17	—	—	—	—	—	1	5.88
Apical depression	17	0 0	6 35.29	11 64.71	0 0%	—	—	—
Apical dots	17	3 17.65	8 47.06	6 35.29%	—	—	—	—
Flatness of fruit	17	7 41.17	3 17.65	7 41.17	0 0	0 0%	—	—
Smoothness of fruit	17	7 41.17	6 35.29	4 23.53	0 0	0 0%	—	—
Thinness of rind	17	14 82.35	3 17.65	0 0	0 0	0 0%	—	—
Thinness of segment wall	17	16 94.12	1 5.88	0 0	0 0	0 0%	—	—
Color of pulp	17	12 70.59	4 23.53	1 5.88	0 0	0 0%	—	—
Size of central column	17	0 0	0 0	9 52.94	5 29.41	3 17.65%	—	—
Quantity of pith	17	1 5.88	3 17.65	13 76.47	0 0	0 0%	—	—
Quality of pulp	17	1 5.88	3 17.65	8 47.06	3 17.65	2 11.76%	—	—

TABLE 190.

MEASUREMENT OF 9 FRUITS (NOS. 10717-10721, 10678, 10682, 10685, & 10687)  
FROM THE NORMAL PART OF THE FUJII WASE FROM  
MIKKABI. LOT NO. 186 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.84 cm.	4.34 cm.	1.31	78.33 gm.	9.00 mm.	10.00	2.39 mm.	9.11 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	9	—	—	—	—	0	% 0
Sinuate based fruits	9	—	—	—	—	0	0
Semi-sinuate based fruits	9	—	—	—	—	0	0
Arcolated fruits	9	—	—	—	—	2	22.22
Frs. with undeveloped calyx lobes	9	—	—	—	—	5	55.56
Frs. with long narrow calyx lobes	9	—	—	—	—	1	11.11
Fruits containing seeds	9	—	—	—	—	0	0
Apical depression	9	0 0	0 0	8 88.89	1 11.11%	—	—
Apical dots	9	3 33.33	2 22.22	4 44.44%	—	—	—
Flatness of fruit	9	0 0	0 0	4 44.44	5 55.56	0 0%	—
Smoothness of fruit	9	0 0	6 66.67	3 33.33	0 0	0 0%	—
Thinness of rind	9	4 44.44	5 55.56	0 0	0 0	0 0%	—
Thinness of segment wall	9	4 44.44	4 44.44	1 11.11	0 0	0 0%	—
Color of pulp	9	8 88.89	1 11.11	0 0	0 0	0 0%	—
Size of central column	9	0 0	0 0	1 11.11	5 55.56	3 33.33%	—
Quantity of pith	9	0 0	1 11.11	6 66.67	2 22.22	0 0%	—
Quality of pulp	9	2 22.22	6 66.67	1 11.11	0 0	0 0%	—

medium-thin, sometimes wavy, adherent. Central column small, pith rather much in quantity but not very unusually abundant. Pulp generally deep-colored, but dark, never bright, the transparency is great, meaty and hard. Vesicles very fine, usually elongate-netted, with an exception of Fruit No. 10719, which has rather coarse vesiculation like Wase. This lot is Owari of rather poor quality. The smoothness of the surface is partly rendered by an infection of sour scab and is not normal, although the fruit is one with a smooth form. More or less sinuous stem end and smaller oil cell dots distinguish it from Wase.

The measurements of these fruits are given in Table 190.\*

### MIKAMI WASE, A REMARKABLE WASE STRAIN FROM FUKUOKA PREFECTURE

The discovery of this interesting bud variation Wase Satsuma is due to the friendly cooperation of Mr. Sainai UCHIDA of the Tachibana village office, who had seen a demonstration on variations of this nature, at the writer's greenhouse in Kyushu Imperial University, and had then made a search with his boy students which finally brought this strain to light. The bud variation tree is located in the orchard of Kusuke MIKAMI, at Jizôdani, Matono, Tachibana-mura, Kasuya-gun, Fukuoka-ken (PL. LIII, Fig. 3 and 3\*). It is on a terrace on the same level as the residence, 2.6 m. higher than the road leading to the house, and the third tree counted from the house, just above the storage house. It was first studied on October 4, 1925, and was again examined on October 8, 1926. It is a purchased plant from the Tanushimaru district of the same prefecture and was planted in 1909. The terrace is 1.45 m. high, facing the SSE, the trees are planted at a distance of about 3.5 m. apart. This tree has a diameter of 2.2 m. in E-W spread, 2.4 m. in N-S spread, and 1.9 m. in height. It is a vigorous tree of rather expanding habit, with large, deep-colored, somewhat boat-shaped, upright leaves often with a lozenge,

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\* PL. XLII, Fig. 2.

acuminate apex. The tree has a main trunk divided into two major stems, the eastern one of which soon sends out a large limb toward the west. This limb sends forth a branch at 1.05 m. from the ground, which soon divides into broadly angled shoots of 29 cm. and 17 cm., respectively. Both shoots bear remarkably large-sized, early-colored, coarse-skinned fruits of decided Wase type. The leaves on this branch are slightly shorter, and more lozenge-shaped, and the somewhat zigzag bearing-shoots hold enormously large buds. The owner says that the fruit matures 23-24 days earlier than that on the other branches. The condition of the soil is rather dry, clayey, about 23 cm. deep, and mulched with straw. As fertilizer, 2 sho (3.6 litres) of powdered silkworm pupa plus a little wood ash is applied. Mr. UCHIDA, examined two fruits in 1924 and verified them as Wase the next year, using a crop of 8 fruits, one of which was taken by the village master of Aoyagi for his own test.

These seven fruits were collected on Nov. 4, 1925 by Mr. UCHIDA, and were sent to the writer; the description of them is given below:

Fruits resemble those of Miyagawa Wase being large-sized, conical, often pointed at base, rarely oblate, tight-skinned, compact and rather heavy. Apex flattened, only slightly concave, with naked area around the styler point and areola. Navel generally open. Base simply flattened, sometimes sinuate, nearly always double-ringed, with fine radial striations. Calyx large, disk also large, flat, demarcation semi-distinct. Surface beautifully colored, with light green patches, rather pitted and not smooth; oil cell dots large, not very conspicuous. Horizontal outline of the fruit is rather uniform, and its conical shape is pronounced.

Cross-section: Rind thin, oil cells large, inner layer colored, not tight. Segment wall considerably thick, especially at the inside area up to  $\frac{1}{3}$  from the center. Central column rather small with abundant quantity of pith. Segment rather irregular, outer end more or less wavy. Pulp very meaty, extremely deep-colored (except in a late bloom fruit, No. 10238), soft, good enough but slightly acidulous. One fruit borne on an inside branch, possibly a late-bloom fruit, No. 10238, has an inferior taste. Vesiculation extremely coarse, vesicle wall rather thickened and distinct.



The measurements of these fruits are given in Table 191.\*

Eleven fruits were collected in 1926, a description of which is given as follows :

Fruits large, the smallest ranks as medium-sized ; shape distinctly conical, some being pyriform. Apex slightly concave, naked area present, areola and navel also present. Base usually strongly concave and grooved, but in small fruits it is flattened like Kawano Wase, the average fruit being perhaps abnormal due to its extremely large size. Calyx large and thick, lobes usually well developed. Disk large, demarcation often faint ; double ring is often marked on its surrounded area. Surface conspicuously oily and bright-colored, oil cell dots very large and dispersed, all being convex, but foveolate in large fruit.

Cross-section : Largest members have thick skin, thick segment wall, abundant pith, with sweet but somewhat insipid pulp, and very coarse-grained, conspicuous vesicles. Medium-sized members have thick rind, comparatively thin (medium) segment wall, small center, and somewhat dried but comparatively good tasting pulp, with very distinct, coarse vesicles. Small members have thin rind, medium-thin wall, slightly larger-sized center, a somewhat decreased amount of pith, and soft, never whitened, more or less over-ripe, medium-tasting pulp. In the larger fruits, the inner layer of the rind occasionally becomes raggy, separating from the pulp ball, but in the smaller ones it is tight and adherent. Segments rather irregular in large fruits, but fairly regular in smaller members.

A few fruits were stored until March 10 in a refrigerator. They all kept very well, without changing flavor, especially the larger ones. Smaller, thin-skinned fruits are subject to souring and do not seem to keep very long. Unquestionably Mikami Wase is a good keeper, as is the case of Miyagawa Wase.

The measurements of these faults are given in Table 192.\*\*

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\* PL. XLII, Fig. 3.

\*\* PL. XLII, Fig. 4.

TABLE 191.

MEASUREMENT OF 7 FRUITS (NOS. 10232-10238) OF THE MIKAMI WASE FROM TACHIBANA, KASUYA-GUN, FUKUOKA PREFECTURE. LOT NO. 166 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
23.66 cm.	5.94 cm.	1.27	177.29 gm.	—	11.19	2.57 mm.	12.14 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	7	—	—	—	—	—	6	85.71%
Sinuate based fruits	7	—	—	—	—	—	0	0
Semi-sinuate based fruits	7	—	—	—	—	—	2	28.57
Areolated fruits	7	—	—	—	—	—	5	71.43
Frs. with undeveloped calyx lobes	7	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	7	—	—	—	—	—	0	0
Fruits containing seeds	7	—	—	—	—	—	0	0
Apical depression	7	0 0	0 0	3 42.86	4 57.14%	—	—	—
Apical dots	7	3 42.86	3 42.86	1 14.29%	—	—	—	—
Flatness of fruit	7	0 0	1 14.29	1 14.29	5 71.29	0 0%	—	—
Smoothness of fruit	7	1 14.29	3 42.86	3 42.86	0 0	0 0%	—	—
Thinness of rind	7	4 57.14	3 42.86	0 0	0 0	0 0%	—	—
Thinness of segment wall	7	0 0	0 0	3 42.86	4 57.14	0 0%	—	—
Color of pulp	7	6 85.71	0 0	0 0	1 14.29	0 0%	—	—
Size of central column	7	0 0	0 0	2 28.57	2 28.57	3 42.86%	—	—
Quantity of pith	7	2 28.57	5 71.43	0 0	0 0	0 0%	—	—
Quality of pulp	7	2 28.57	4 57.14	1 14.29	0 0	0 0%	—	—

TABLE 192.

MEASUREMENT OF 11 FRUITS (NOS. 10630-10640) OF THE MIKAMI WASE  
FROM TACHIBANA, FUKUOKA PREFECTURE. LOT NO. 180 OF 1928.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
24.25 cm.	6.77 cm.	1.14	182.00 gm.	12.27 mm.	10.27	4.20 mm.	10.55 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	11	—	—	—	—	—	7	% 63.64
Sinuate based fruits	11	—	—	—	—	—	0	0
Semi-sinuate based fruits	11	—	—	—	—	—	0	0
Areolated fruits	11	—	—	—	—	—	10	90.91
Frs. with undeveloped calyx lobes	11	—	—	—	—	—	1	9.09
Frs. with long narrow calyx lobes	11	—	—	—	—	—	0	0
Fruits containing seeds	11	—	—	—	—	—	0	0
Apical depression	11	0 0	0 0	11 100.00	0 0%	—	—	—
Apical dots	11	3 27.27	8 72.73	0 0%	—	—	—	—
Flatness of fruit	11	0 0	0 0	1 9.09	6 54.55	4 36.36%	—	—
Smoothness of fruit	11	0 0	2 18.18	5 45.45	4 36.36	0 0%	—	—
Thinness of rind	11	0 0	1 9.09	3 27.27	1 9.09	6 54.55%	—	—
Thinness of segment wall	11	1 9.09	5 45.45	1 9.09	3 27.27	1 9.09%	—	—
Color of pulp	11	11 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	11	0 0	0 0	0 0	5 45.45	6 54.55%	—	—
Quantity of pith	11	6 54.54	4 36.36	1 9.09	0 0	0 0%	—	—
Quality of pulp	11	3 27.27	7 63.64	1 9.09	0 0	0 0%	—	—

## **NORMAL PART OF MIKAMI'S BUD VARIATION TREE AT TACHIBANA**

Eighty fruits picked from the whole of the bud variation tree owned by Kuhei MIKAMI, excepting those on the mutating limb, were sent to the writer in December, 1925. They are described as follows :

Fruits medium-sized, ranging to small, roundish, often conical, rather compact but not very heavy. Apex shallowly concave in a small area, rarely flat or broadly concave, having a tendency to show excavated stylar end within the areola ridge. Percentage of navel rather large, areola usually present, the inside area usually contains a small number of oil cell dots, but is sometimes quite naked ; rarely the stylar end shows a projection made by the presence of a very few extremely large dots nearby. Base sinuate at the calyx end, often deeply grooved, in some rare cases a double ring is present, no fine, radiating striations. Calyx normal, small, well lobed, lobes thin, light-colored. Surface pitted, rough, but not very rough, sometimes quite even but never smooth. Color deep, oil cell dots much glazed. No blemishes. This is a normal Zairai, prevalent in this prefecture.

Cross-section : Rind thick, much pith of rind, colored and rather solid ; oil cells large, distinct, close, usually in one row, sometimes elongated. Segment wall also thick up to the half way from the center. Central column medium to rather large, with a large amount of white pith. Pulp deep-colored, meaty, rather soft, of fairly good quality but decidedly acidulous, not very palatable. Vesicles rather distinct, more or less netted. Seedy fruits rather many. Tested on December 5, 1925.

The measurements of these fruits are given in Table 193.\*

## **SHIN AIKAWA WASE OR THE SECOND BUD VARIATION STRAIN FOUND IN AIKAWA'S ORCHARD AT IKIRIKI VILLAGE, NAGASAKI PREFECTURE**

When the writer visited for the second time the orchard owned by Mr. Takaichirô AIKAWA on October 8, 1925, this bud variation tree was

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\* PL. XLIII, Fig. 2.

TABLE 193.

MEASUREMENT OF 80 FRUITS (NOS. 10529-10607) FROM THE NORMAL  
PART OF MIKAMI'S BUD VARIATION TREE AT TACHIBANA,  
FUKUOKA PREFECTURE. LOT NO. 178 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.39 cm.	4.48 cm.	1.31	80.05 gm.	9.83 mm.	10.61	3.09 mm.	11.40 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	80	—	—	—	—	—	25	31.25%
Sinuate based fruits	80	—	—	—	—	—	66	82.50
Semi-sinuate based fruits	80	—	—	—	—	—	12	15.00
Areolated fruits	80	—	—	—	—	—	38	47.50
Frs. with undeveloped calyx lobes	80	—	—	—	—	—	8	10.00
Frs. with long narrow calyx lobes	80	—	—	—	—	—	0	0
Fruits containing seeds	80	—	—	—	—	—	19	23.75
Apical depression	79	0 0	3 3.80	67 84.81	9 11.40%	—	—	—
Apical dots	78	13 16.87	45 57.69	20 25.64%	—	—	—	—
Flatness of fruit	80	0 0	4 5.00	55 68.75	18 22.50	3 3.75%	—	—
Smoothness of fruit	80	0 0	12 15.00	39 48.75	18 22.50	11 13.75%	—	—
Thinness of rind	80	1 1.25	11 13.75	46 57.50	17 21.25	5 6.25%	—	—
Thinness of segment wall	80	21 26.25	31 38.75	26 32.50	2 2.50	0 0%	—	—
Color of pulp	80	64 80.00	14 17.50	2 2.50	0 0	0 0%	—	—
Size of central column	80	0 0	15 18.75	59 73.75	4 5.00	2 2.50%	—	—
Quantity of pith	80	2 2.50	40 50.00	38 47.50	0 0	0 0%	—	—
Quality of pulp	80	6 7.50	21 26.25	37 46.25	13 16.25	3 3.75%	—	—

accidentally found. This is the second tree from the old Aikawa Wase tree on the north, or the second tree from the south end of the plot. The terrace is 2.6 m. wide and this tree spreads 2.6 m. in the N-S direction, 2.38 m. in the E-W direction, and is 2.2 m. high. The tree has a short common trunk which divides into two large stems, one leading toward the east, the other running upright, gradually turning to the west. The latter, at the very end bending slightly down, bears a small shoot at a height of 1.19 m. from the ground. This shoot is only 20 cm. long, but bore at the time two large fruits and two buttons without fruits (stolen). One of the fruits examined has a girth of 33 cm., while the average fruit of other branch is only 18 cm. The fruit differs a great deal from the latter by having an extremely smooth and shiny skin, which already shows intense color at the apex. On opening the fruit above mentioned, it was found that it has 11 segments, thin rind measuring 1.5-2 mm., medium-sized central column measuring  $16 \times 13$  mm. with medium-much quantity of pith. The pulp is good and the vesicles decidedly coarse-grained, typical of Wase. A normal fruit from an other branch showed a thicker rind, measuring 2-2.5 mm., a thinner segment wall, and decidedly more acidulous, finely grained pulp. The contrast between these fruits is enough to give the conclusion that the former is Wase. The leaves of this tree are large, broad, deep-colored, standing on elongated internodes, and the few branches are sent out at random exactly characteristic of the Ikiriki type of the Owari variety. The fruit is also flat and large, not so roundish as on the variation branch. The leaves on the variation branch are much crowded, thick, small, twisted; some are short and broad, and some are more or less slender. The shoots bearing these leaves are decidedly zigzag, with very short internodes. This variation branch is to be watched in coming years, but the habit of fruiting, the crop on it, and the leaf characters can safely be alluded to as Wase, although future investigations are required to decide the real character of the fruit.

The tree is fertilized with 1 sho (1.8 litres) of sesamum seed press cake, about 2 sho (36 litre) of super-phosphate of lime, at the first application, and about one-half sho (91 litre) of fish cake is given at the

second. The surface soil is about 17–20 cm. deep and subsoil is light red in color, mixed with some stones. It looks like very fertile light brown loam, containing fine archean angular pebbles about 1 cm. in diameter. It is interesting to find such a frequent bud variation upon very rich soil like this and in such a warm place as Ikiriki village.

### MORITA WASE, A NEW MIKKABI BUD VARIATION IN 1926

In the fall of 1926, the writer made a trip with Dr. W. T. SWINGLE to various localities in Japan and the following are those strains found or first jointly and critically studied during this trip.

The Morita Wase tree was known to the writer since November 1924, but the tree was not bearing in that and the following years. In 1924, the plant looked extremely poor, due to a severe infection by the leaf-roller moth. The orchard belonging to Heizaburō MORITA is a flat land facing a cemetery on the eastern side, and is planted with Satsuma orange trees 3.5 m. apart in both directions. The tree in question the fourth tree from the south (a path), on the first easternmost row (PL. LIII, Fig. 4, 4a, and 5). This is an old-looking tree of somewhat bushy habit, having a spread of  $2.8 \times 2.6$  m. in diameter and being 2.23 m. in height. The trunk is upright, with many erect primary stems; it has a girth of 32 cm. above the union of the stock, and 28 cm. just below the departure of the first horizontal branch running south. A southern branch at 136.5 cm. from the first fork of the trunk, or 120.5 m. from the ground, has a branch about 60 cm. long. This branch runs horizontally about 38 cm. and suddenly curves down reaching about 30 cm. away where an enormous swelling takes place. In 1926, a crop of 45 fruits were crowded on shoots arising from this swelling. No normal leaves are found on any part of the tree, and MATSUI said that this tree defoliates every year. The other trees in the same orchard look to be Owari by their large, hanging leaves and large, flat fruits. In 1926, the difference in the coloring of the fruit was very conspicuous. The leaves on the variation branch, studied in April, 1926, showed typical twisting and an upright habit, and the shoots bearing showed

TABLE 194.

MEASUREMENT OF 10 FRUITS (NOS. 10900-10909) OF THE MORITA WASE  
FROM MIKKABI, SHIDZUOKA PREFECTURE. LOT NO. 198 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
15.41 cm.	3.96 cm.	1.24	52.50 gm.	8.80 mm.	9.80	1.75 mm.	7.90 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	10	—	—	—	—	—	0	% 0
Sinuate based fruits	10	—	—	—	—	—	0	0
Semi-sinuate based fruits	10	—	—	—	—	—	0	0
Areolated fruits	10	—	—	—	—	—	3	30.00
Frs. with undeveloped calyx lobes	10	—	—	—	—	—	6	60.00
Frs. with long narrow calyx lobes	10	—	—	—	—	—	0	0
Fruits containing seeds	10	—	—	—	—	—	0	0
Apical depression	10	0 0	0 0	3 30.00	7 70.00%	—	—	—
Apical dots	10	0 0	7 70.00	3 30.00%	—	—	—	—
Flatness of fruit	10	0 0	0 0	1 10.00	7 70.00	2 20.00%	—	—
Smoothness of fruit	10	7 70.00	3 30.00	0 0	0 0	0 0%	—	—
Thinness of rind	10	10 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	10	10 100.00	0 0	0 0	0 0	0 0%	—	—
Color of pulp	10	10 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	10	0 0	0 0	1 10.00	3 30.00	6 60.00%	—	—
Quantity of pith	10	0 0	0 0	7 70.00	2 20.00	1 10.00%	—	—
Quality of pulp	10	10 100.00	0 0	0 0	0 0	0 0%	—	—



characteristic short internodes and large buds. The soil of the orchard is poor containing many pebbles. The plant is lightly mulched with straw and apparently is not well fertilized. The variation is said to have known since the 1918-1919 season, and was perhaps first detected by Shōzō NATSUME of the village office.

Fruits received in 1926 are described as follows:

Fruits small, very round and regular in outline. Apex rounded, almost not concave, naked area around the styler point almost absent; navels all closed, areola absent in almost all. Base rounded, almost not concave at the stem-end. Calyx small, lobes short, not well developed; disk more or less large, strongly marked, fine striations radiating from the calyx. Surface very smooth, in all bright-colored; oil cell dots equally medium-large, close together and distinct, all even slightly convex, never forming fovea.

Cross-section: Rind thin, rather porous, segment wall thin, rather adherent, central column small, irregular in shape, filled with soft, fairly abundant pith. Segments rather irregular. Pulp very deep-colored, extremely sweet, soft, and meaty. Vesiculation quite indistinct, looking almost like one mass, but the individual vesicles are large. This is the most intensely flavored Wase being almost as sweet as the Ponkan (*Citrus poonensis* HORT.), although it has an objectionably small size.

The measurements of fruits are given in Table 194.\*

### NORMAL PART OF THE MORITA WASE TREE

The fruits of the normal part of the Morita Wase bud variation tree are very much like those of the variations branch, presumably an Ikeda tree of unknown origin. Eleven fruits were collected in 1926 and sent to the writer by Mr. MATSUL. The following is a description of these fruits:

Fruits very small, round, tall, rarely depressed (No. 10778), outline regular, both shoulders well rounded. Apex only slightly concave, navel not developed, fine oil cell dots reach to the styler point, without leaving any naked area. Areola generally distinct. Base slightly sinuous,

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\* PL. XLIII, Fig. 1.

TABLE 195.

MEASUREMENT OF 11 FRUITS (NOS. 10768-10778) FROM THE NORMAL PART  
OF THE MORITA WASE TREE AT MIKKABI LOT NO. 192 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
15.85 cm.	3.94 cm.	1.28	54.64 gm.	9.00 mm.	10.18	2.14 mm.	9.00 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	11	—	—	—	—	0	% 0
Sinuate based fruits	11	—	—	—	—	9	81.82
Semi-sinuate based fruits	11	—	—	—	—	0	0
Areolated fruits	11	—	—	—	—	10	90.91
Frs. with undeveloped calyx lobes	10	—	—	—	—	4	40.00
Frs. with long narrow calyx lobes	10	—	—	—	—	0	0
Fruits containing seeds	11	—	—	—	—	0	0
Apical depression	11	0 0	0 0	11 100.00	0 0%	—	—
Apical dots	11	0 0	5 45.45	6 54.55%	—	—	—
Flatness of fruit	11	0 0	2 18.18	5 45.45	4 36.36	0 0%	—
Smoothness of fruit	11	0 0	8 72.73	3 27.27	0 0	0 0%	—
Thinness of rind	11	3 27.27	6 54.54	2 18.18	0 0	0 0%	—
Thinness of segment wall	11	11 100.00	0 0	0 0	0 0	0 0%	—
Color of pulp	11	9 81.82	2 18.18	0 0	0 0	0 0%	—
Size of central column	11	0 0	0 0	4 36.36	7 63.64	0 0%	—
Quantity of pith	11	0 0	0 0	7 63.64	4 36.36	0 0%	—
Quality of pulp	11	7 63.64	4 36.36	0 0	0 0	0 0%	—

calyx rather small, often elevated, and lobes poorly developed, many fruits. Disk not conspicuous. Surface nearly even but more or less pitted; oil cell dots fine, either pitted or slightly convex, but never prominent as in Wase fruits. No fruit has strong foveoli, but some fruit (Nos. 10768, 10778) are distinctly pitted.

Cross-section: Rind rather thin, ranging from very thin to medium, pith rather soft. Segment wall thin in all fruits but not weak. Central column small, pith medium or less than medium in quantity. Size of segments rather irregular, outer corner more or less rounded, inner end also rounded. Number of segments rather few. Pulp intensely flavored, of good quality, deep-colored. Vesicle arrangement always parallel, not anastomose as in Wase fruits, distinct and more or less strong, not melting.

This cannot be an Owari, as it has such round fruits, small central column, few segments, strong, more or less late-maturing, intensely flavored pulp, and few elongated pulp vesicles.

The measurements of the these fruits are given in Table 195.\*

### **SATÔ WASE, ANOTHER MIKKABI BUD MUTANT**

In April, 1926, the writer was taken by Mr. MATSUI to the plant owned by Ushinosuke SATÔ the fruit of which was studied in 1925. Only Wase fruits were sent in this year, and the study was completed in 1926, after comparing the Wase fruit with that of the normal part.

Mr. SATÔ's orchard is located at the east of the Kainangumi plantation, on level land, planted with uniform-looking Owari plants set out in 1911. The tree in question is located in the second row from the west, the plant next to the southernmost one (PL. LIII, Fig. 6, 6a, 7). It is a small tree 3.5 m. wide in E-W spread, 2.6 wide in N-S spread and 4.35 m. high. The plant has a single trunk, forked into two stems. The western stem has a thick secondary limb running toward the east, and the latter has a branch at a point 84 cm. from the ground. This branch runs parallel to its mother limb at a very acute angle, leaving

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\* PL. XLIII, Fig. 2.

a mark pressed on the surface of the latter. This branch of 72 cm. in total length hangs down, facing the south. This is rather a pocket branch, the terminal part of which is more or less zigzag, bearing contorted, light-colored, broad leaves typical of Wase.

The tree came from Shinbara, Akasa-mura, Hamana-gun, where only the Owari variety is extensively cultivated. The soil of this orchard is sandy, receiving shallow straw mulch. The whole orchard looks beautifully uniform, well cared and heavily fertilized, winning high honor on that account at the local orchard contest. The owner said that the variation was found in 1924, and he reported this finding to Mr. Sôtarô NAKAGAWA horticulturist of the Citrus Growers' Association. Later it was reported to the writer through Mr. MATSUI.

A description of 20 fruits received in 1925 is given below :

Fruits ranging from medium to small, oblate, good-looking. Apex gradually broad-concave, generally areolate, areola mostly pitted and the included apical area sometimes suddenly depressed. Navel not prominent, though occasionally present. Base quite rounded, stem-end usually sinuous and very occasionally double-ringed. Calyx normal, rather small, some with undeveloped lobes, rarely with elongated lobes. Surface even or pitted, beautifully orange-colored, oil cell dots normal size, quite Wase-like, never very large, uniform in size, even or slightly concave, sometimes forming sharp fovea. The general appearance of the fruits is not very typical of Wase, but the cross-section is undoubtedly Wase in every respect, resembling that of Higuchi Wase.

Cross-section : Rind thin, segment wall rather thick, only rarely thin (No. 9924), average much thicker in comparison with the thinness of the rind. Central column rather small, with pith rather solid and much in quantity. Pulp extremely deep-colored, soft, juicy, and of good quality. Vesiculation coarse, but not drying; in over-ripe fruit vesicles rather separate from one another. The general character is excellent with a honey-like flavor to the pulp.

The measurements of these fruits are given in Table 196.\*

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\* PL. XLIII, Fig. 3.

TABLE 196.

MEASUREMENT OF 20 FRUITS (NOS. 9907-9926) OF THE SATO WASE FROM  
MIKKABI, SHIDZUOKA PREFECTURE LOT NO. 159 OF 1925.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.96 cm.	4.35 cm.	1.36	86.25 gm.	9.30 mm.	10.85	2.24 mm.	11.15 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	20	—	—	—	—	—	6	% 30.00
Sinuate based fruits	20	—	—	—	—	—	17	85.00
Semi-sinuate based fruits	20	—	—	—	—	—	0	0
Areolated fruits	20	—	—	—	—	—	13	65.00
Frs. with undeveloped calyx lobes	20	—	—	—	—	—	6	30.00
Frs. with long narrow calyx lobes	20	—	—	—	—	—	1	5.00
Fruits containing seeds	20	—	—	—	—	—	0	0
Apical depression	20	2 10.00	14 70.00	4 20.00	0 0%	—	—	—
Apical dots	20	1 5.00	15 75.00	4 20.00%	—	—	—	—
Flatness of fruit	20	0 0	18 90.00	2 10.00	0 0	0 0%	—	—
Smoothness of fruit	20	0 0	10 50.00	9 45.00	1 5.00	0 0%	—	—
Thinness of rind	20	15 75.00	5 25.00	0 0	0 0	0 0%	—	—
Thinness of segment wall	20	1 5.00	9 45.00	8 40.00	2 10.00	0 0%	—	—
Color of pulp	20	20 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	20	0 0	0 0	15 75.00	4 20.00	1 5.00%	—	—
Quantity of pith	20	1 5.00	8 40.00	11 55.00	0 0	0 0%	—	—
Quality of pulp	20	16 80.00	3 15.00	1 5.00	0 0	0 0%	—	—

TABLE 197.

MEASUREMENT OF 6 FRUITS (NOS. 10740-10745) OF THE SATO WASE FROM  
MIKKABI, SHIDZUOKA PREFECTURE. LOT NO. 188 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.35 cm.	5.08 cm.	1.28	113.16 gm.	16.67 mm.	10.67	2.33 mm.	12.00 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	6	—	—	—	—	0	% 0
Sinuate based fruits	6	—	—	—	—	0	0
Semi-sinuate based fruits	6	—	—	—	—	0	0
Areolated fruits	6	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	6	—	—	—	—	2	33.33
Frs. with long narrow calyx lobes	6	—	—	—	—	0	0
Fruits containing seeds	6	—	—	—	—	0	0
Apical depression	6	0 0	0 0	1 16.67	5 83.33%	—	—
Apical dots	6	0 0	3 50.00	5 50.00%	—	—	—
Flatness of fruit	6	0 0	0 0	4 66.67	2 33.33	0 0%	—
Smoothness of fruit	6	4 66.67	2 33.33	0 0	0 0	0 0%	—
Thinness of rind	6	5 83.33	1 16.67	0 0	0 0	0 0%	—
Thinness of segment wall	6	2 33.33	4 66.67	0 0	0 0	0 0%	—
Color of pulp	6	5 83.33	1 16.67	0 0	0 0	0 0%	—
Size of central column	6	0 0	0 0	4 66.67	1 16.67	1 16.67%	—
Quantity of pith	6	0 0	0 0	4 66.67	2 33.33	0 0%	—
Quality of pulp	6	5 83.33	1 16.67	0 0	0 0	0 0%	—

Six fruits received in 1926 are described below :

Fruits uniform, good-looking, size large to small, not rectangular but with slender shoulder. Apex almost without depression (except No. 10744), dots present up to the stylar point; areola sometimes present and navel closed. Base very smooth, no depression at the stem end. Calyx uniformly large, disk not prominent, though slightly large, fine radial striations exist but no double ring. Surface extra-ordinary, even but not polished, color uniform, not intense, very slightly greenish (observed on Dec. 5). Oil cell dots uniform, equally raised, close, not large, never concave. A very uniform, beautiful-shaped Wase attaining a good size.

Cross-section : Rind thin or very thin, rather adherent to the pulp ball, and brittle; segment wall medium-thin to very thin. Segments rather irregular, corner sometimes angular. Central column medium-small, with moderately much pith. Pulp very deep-colored, of fairly good quality, keeping fairly well (the last one was kept until Jan. 9, 1927). Pulp vesicles not very coarse but larger than those of the Owari fruit, vesicle wall subdistinct, but never becoming white, well reticulate. The quality of fruit is good but not excellent. The appearance of the fruit somewhat resembles Sueoka Wase, but the quality is not so superior. When over-ripe, pulp vesicles become more or less free, as noticed in the previous year. It is a beautiful Wase and the quality of the pulp may be improved when special care is taken.

The measurements of these fruits given in Table 197.\*

### FRUITS FROM THE NORMAL PART OF THE SATÔ WASE

Six fruits were received from the normal part of the Satô Wase bud variation tree in 1926. These fruits are described as follows :

Fruits rather small, ranging to very small; uniform in shape and in having a slender shoulder. Apex rounded, stylar point flat, dots reaching to the end, areola all present, navel closed. Base rounded, calyx end slightly sinuous. Calyx large, some with elongated lobes;

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\* PL. XLIII, Fig. 4.

TABLE 198.

MEASUREMENT OF 6 FRUITS (NOS. 10746-10751) FROM THE NORMAL  
PART OF SATO WASE FROM MIKKABI, SHIDZUOKA  
PREFECTURE. LOT NO. 189 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.98 cm.	4.55 cm.	1.26	80.00 gm.	10.67 mm.	10.67	2.75 mm.	9.25 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	6	—	—	—	—	0	% 0
Sinuate based fruits	6	—	—	—	—	6	100.00
Semi-sinuate based fruits	6	—	—	—	—	0	0
Areolated fruits	6	—	—	—	—	3	50.00
Frs. with undeveloped calyx lobes	6	—	—	—	—	1	16.67
Frs. with long narrow calyx lobes	6	—	—	—	—	2	33.33
Fruits containing seeds	6	—	—	—	—	0	0
Apical depression	6	0 0	0 0	5 83.33%	1 16.67%	—	—
Apical dots	6	0 0	0 0	6 100.00	—	—	—
Flatness of fruit	6	0 0	0 0	4 66.67	2 33.33	0 0%	—
Smoothness of fruit	6	0 0	1 16.67	4 66.67	1 16.67	0 0%	—
Thinness of rind	6	0 0	4 66.67	2 33.33	0 0	0 0%	—
Thinness of segment wall	6	3 50.00	3 50.00	0 0	0 0	0 0%	—
Color of pulp	6	6 100.00	0 0	0 0	0 0	0 0%	—
Size of central column	6	0 0	0 0	0 0	6 100.00	0 0%	—
Quantity of pith	6	0 0	4 66.67	2 33.33	0 0	0 0%	—
Quality of pulp	6	3 50.00	2 33.33	1 16.67	0 0	0 0%	—



disk rather small, rarely concealed under the calyx; radial striations generally present. Surface nearly even or harshed, oil cell dots conspicuously smaller than those of the Wase, regularly pitted with a distance. Color still green when observed on Dec. 5; russet with sour-scab infection. This is a straight Owari of no particular interest.

Cross-section: Rind medium-thin to medium, solid, leathery, adherent to pulp ball. Segment wall thin to medium-thin, more or less undulate. Central column rather small, pith much in quantity. Segments rather regular, outer corner rather angular, inner and often chisel-pointed. Pulp deep-colored, not bright, dark, meaty, hard, rather intensely flavored but acidulous, of rather good quality. Vesiculation almost invisible, very fine, elongated, fairly parallel. This is an Owari of ordinary quality.

The measurements of these fruits are given in Table 198.\*

### OKAMOTO WASE, FROM AN ISLAND OF THE INLAND SEA

In visiting Mr. Yûjirô YUKIZAKI at the Citrus Experimental Farm of the Hiroshima Agricultural Experiment Station, the writer was told that he had found a bud variation tree in Iwashijima Island of the same prefecture. On visiting the island under the guidance of Mr. YUKIZAKI, the plant was easily located in an orchard owned by Kiichirô OKAMOTO, Iwashijima-mûra, Mitsugi-gun, Hiroshima-ken (PL. LIII, Fig. 7, 7a, and 7b). It was found in a very good condition, under the good care and excellent management of the owner. By going down a path leading toward the sea, one passes by a mulberry grove and finds the plant on the right hand side, in an inside row between the third and forth Satsuma rows. The land slopes slightly down toward both east and west, although this part of the orchard is nearly flat, not very high above sea level. The plant has a spread of 3.5 m. in diameter and a height of 2.6 m. It is a very vigorous looking, low tree with a large root crown, a very short main trunk, and two large stems branching repeatedly. The northern branch, at a height of 1.1 m. from the ground, has a normal branch standing upright, and the farther end, measuring

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\* PL. XLIII, Fig. 5.

81 cm. bears an entirely different kind of fruit. This limb has two branches, the lower one of which has a roughened surface just after it starts, lasting about 15 cm. The distal end of this branch, that is a length of 38 cm., bears many fruits of Wase character. The whole tree is vigorous, with much foliage. The shoots are upright and healthy. The leaves are green and large; and the fruit is large, flat, pitted, and deep green when observed on Oct. 16, 1926. The variation branch is about the same in the character of the leaves but the blade is slightly smaller, and the leaf buds are extremely large, typical of Wase. The fruits observed in the field were all very large, very smooth, almost showing color at the apex. Some late-bloom fruits borne on the same limb looked quite unripe. The tree was originally grafted by the owner in about 1902, using a scion taken from a tree planted near his house. The mother tree is a 70-80 year old Owari Satsuma, according to the owner's statement. The bud variation was first found by him in 1912, it became a good bearer in the last five or six years. The soil is sandy; mulched with straw, and fertilizers of three elements combined are applied at a ratio of 10 kwan (37.5 kg.) per tan (9.9 ares).

The fruits of the Okamoto Wase, so named by the writer in 1927<sup>(17)</sup>, are described as follows:

Fruits ranging from large to medium-small, larger ones fairly big in size, graduation being continuous. Outline of the fruit is rather irregular in circumference and in height and none is tall and rectangular but tends to elongate toward the base, resuming a slight pyriform. Some fruit is very much pointed at the base, looking almost trigonal, though some is quite flat. Apex simply flat, concavity at the styler end very little. Naked area around the styler point, areola ring and navel, all usually present. Base generally sinuous at the stem-end, often with double ring (very strongly so in No. 10783), and the radial striations mostly distinct. Calyx very large, tube part especially large, lobes often elongate, sometimes not well developed. Disk very large, often with faint demarcation. Surface beautifully colored (examined on Dec. 7), bright, somewhat glazed, even, good looking. Oil cell dots very large and conspicuous and generally all convex.

TABLE 199.

MEASUREMENT OF 16 FRUITS (NOS. 10779-10794) OF THE OKAMOTO WASE  
FROM IWASHIJIMA ISLAND, MITSUGI-GUN, HIROSHIMA  
PREFECTURE. LOT NO. 193 OF 1928.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
22.04 cm.	5.71 cm.	1.23	151.44 gm.	11.19 mm.	10.06	2.45 mm.	13.66 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	16	—	—	—	—	—	5	31.25%
Sinuate based fruits	16	—	—	—	—	—	14	87.50
Semi-sinuate based fruits	16	—	—	—	—	—	0	0
Areolated fruits	16	—	—	—	—	—	7	43.75
Frs. with undeveloped calyx lobes	16	—	—	—	—	—	4	25.00
Frs. with long narrow calyx lobes	16	—	—	—	—	—	3	18.75
Fruits containing seeds	16	—	—	—	—	—	0	0
Apical depression	16	1 6.25	0 0	14 87.50	1 6.25%	—	—	—
Apical dots	16	7 43.75	8 50.00	1 6.25%	—	—	—	—
Flatness of fruit	16	0 0	1 6.25	10 62.50	5 31.25	0 0%	—	—
Smoothness of fruit	16	5 31.25	10 62.50	1 6.25	0 0	0 0%	—	—
Thinness of rind	16	15 93.75	1 6.25	0 0	0 0	0 0%	—	—
Thinness of segment wall	16	9 56.25	6 37.50	1 6.25	0 0	0 0%	—	—
Color of pulp	16	16 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	16	1 6.25	2 12.50	7 43.75	5 31.25	1 6.25%	—	—
Quantity of pith	16	0 0	2 12.50	7 43.75	7 43.75	0 0	—	—
Quality of pulp	16	11 68.75	5 31.25	0 0	0 0	0 0%	—	—

Cross-section: Rind homogenously thin. Segment wall thin to medium-thin, in large fruits it is abruptly thickened near the center. Central columns variable in size, some fairly open, but average rather small, pith not much but rather adherent to the segment. Segments rather irregular, varying in breadth, usually few in number; outer corner somewhat angular and the margin more or less undulate, inner end rounded, rather difficult to separate. Pulp extremely deep-colored, of utmost beauty, juicy and sweet, never insipid, kept well until Jan. 1, 1927. The vesiculation very coarse, distinct, anastomosing; individual vesicles being visible but not whitened.

The measurements of these fruits are given in Table 199.\*

### FRUITS FROM THE NORMAL PART OF THE OKAMOTO WASE TREE

Fruits Owari-like; flat, sometimes more or less tall, but always abruptly compressed at the base; outline regular, more or less puffy looking. Apex broadly and deeply concave, naked area often present, associated with abrupt depression at the styler end and large pitted areola; navel very frequently present. Base broadly flattened, stem-end strongly concave, often with conspicuous radial grooves. Calyx and disk large, but the lobes normal, well developed. Surface bright-colored without green spots (observed on Dec. 8), pitted like Owari, entirely different from the Wase fruits borne on the same tree.

Cross-section: Rind more or less thick, porous, soft, becoming loose. Segment wall thin; central column moderately large, hollow, pith very little in amount. Number of segments many, outer corner more or less angular, margin somewhat undulate, inner end sharply pitted, often fastened with pith, but its amount is not great. Pulp equally good-colored, juicy, soft and moderately sweet (not intense nor sour), and palatable, of fair quality. Vesiculation invisible, fine, uniformly elongate-netted.

This is an Owari typical of the variety, having fairly uniform size

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\* PL. XLIV, Fig. 1.

TABLE 200.

MEASUREMENT OF 24 FRUITS (NOS. 10795-10818) FROM THE NORMAL PART  
OF OKAMOTO'S BUD VARIATION WASE TREE IN HIROSHIMA  
PREFECTURE. LOT NO. 194 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.32 cm.	4.75 cm.	1.43	109.07 gm.	11.34 mm.	11.33	3.34 mm.	13.96 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	24	—	—	—	—	—	14	58.33%
Sinuate based fruits	24	—	—	—	—	—	4	16.67
Semi-sinuate based fruits	24	—	—	—	—	—	3	12.50
Areolated fruits	24	—	—	—	—	—	18	75.00
Frs. with undeveloped calyx lobes	24	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	24	—	—	—	—	—	0	0
Fruits containing seeds	24	—	—	—	—	—	2	8.33
Apical depression	24	<sup>7</sup> 29.17	<sup>13</sup> 54.17	<sup>4</sup> 16.67	<sup>0</sup> 0%	—	—	—
Apical dots	24	<sup>3</sup> 12.50	<sup>20</sup> 83.33	<sup>1</sup> 4.17%	—	—	—	—
Flatness of fruit	24	<sup>21</sup> 87.50	<sup>3</sup> 12.50	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Smoothness of fruit	24	<sup>0</sup> 0	<sup>0</sup> 0	<sup>18</sup> 75.00	<sup>5</sup> 20.83	<sup>1</sup> 4.17%	—	—
Thinness of rind	24	<sup>0</sup> 0	<sup>5</sup> 20.83	<sup>14</sup> 58.33	<sup>4</sup> 16.67	<sup>1</sup> 4.17%	—	—
Thinness of segment wall	24	<sup>24</sup> 100.00	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Color of pulp	24	<sup>24</sup> 100.00	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Size of central column	24	<sup>1</sup> 4.17	<sup>3</sup> 12.50	<sup>18</sup> 75.00	<sup>1</sup> 4.17	<sup>1</sup> 4.17%	—	—
Quantity of pith	24	<sup>0</sup> 0	<sup>0</sup> 0	<sup>9</sup> 37.50	<sup>9</sup> 37.50	<sup>6</sup> 25.00%	—	—
Quality of pulp	24	<sup>20</sup> 83.33	<sup>4</sup> 16.67	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—

and quality. Puffing is noticed to a certain extent but is not serious to any degree.

The measurements of these fruits are given in Table 200.\*

### ÔSUGI WASE, THE SECOND BUD VARIATION TREE AT TSUKUMI, ÔITA PREFECTURE

On the occasion of investigating the Higuchi Wase at Tsukumi in 1926, the existence of another bud variation tree was pointed out by a villager, and this was confirmed by an actual visit to the plant. This Wase was subsequently named ÔSUGI Wase<sup>(175)</sup>. The plant is in an orchard owned by Minatarô ÔSUGI, Dôbata, Hikonouchi, Tsukumi-mura, Kitaamabe-gun, Ôita-ken (PL. LIII, Fig. 8 and 8<sup>a</sup>). It is planted on a slope facing the W-W-N direction and is the fourth plant from the north on the seventh terrace. It is a rather large tree of about  $3.5 \times 2.6$  m. in spread and 2.6 m. high, planted in about 1886. It has a thick trunk, which divides into two large stems and one other smaller stem; the leading south-eastern stem extends far in the direction of the upper terrace, spreading over its surface. Following this leader, one reaches a slightly swollen part with an uneven surface at about 1.9 m. above the ground. This part is at distance of 48 cm. from the upright branch of the same limb, and has a girth of 12.5 cm. at the base and 15 cm. at the swollen portion. Many shoots coming out from the end of the swollen portion bear entirely different fruits. This part has a length of 58 cm. and a height of 72 cm., and the fruits borne on this part look larger and are slightly ribbed. The leaves on this branch look normal, being large, long, and vigorous in appearance, not typical of Wase. It is said that too large a crop was borne last year and the size of the fruits this year is not normal. The owner first found this particular branch about ten years ago, but he only regarded it as a bud variation Wase in 1920, after hearing a talk by Mr. Ejûrô SHIMOMURA. These fruits ripen about a month earlier than the fruits on the other branches,

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\* PL. XLIV, Fig. 2.

and the ribbing was really noticed for the first time this year. The soil is a rich gravel loam, and the plant is mulched with straw, appearing pretty well fertilized.

Thirty-five variation fruits were later sent to the writer for investigation, which are described below :

Fruits large-sized, ranging to medium-small ; shape generally varying, mostly flat but sometimes narrowed at the base assuming a conical shape ; horizontal outline irregular. Apex depressed in various grades, average not very concave, sometimes flat, rarely broad-concave. Naked area around the styler point often very pronounced. Navel not developed. Base also depressed in various degrees but not deep-concave, although in ribbed fruits the depression is rather deep and radially grooved. Calyx variable in size, often with elongated lobes, sometimes almost lobe-less. Disk often large and with faint demarcation. The surrounding area flat, even in double-ringed fruit. Surface is good in color, but not polished ; many fruits have distinct ribs which are elevated areas running longitudinally with rather indefinite margins and carry very large, pustulate oil cell dots. Oil cell dots generally prominent, all convex, often reaching an enormous size. This is the first Wase strain which has ribbed fruits.

Cross-section ; Rind thin to medium, comparatively strong and durable, undulate due to ribbing : the oil cells on the ribs extremely large. Segment wall more or less thick, sometimes medium. Central column medium-sized, pith not much, but more or less thick in lining the interior end of the segment wall. Segments not variable in size, few in number, large, corners rounded, inner ends also rounded. Pulp somewhat variable in color, usually deep-colored, intensely sweet, meaty, soft, of extremely good quality. Vesiculation not coarse to a great extent, individual vesicles not very non-uniform in size, later they become sugary and whitened. Some fruit was kept until February 11, 1927 and still tasted very good, so that the ability to keep is remarkably good.

The measurements of these fruits are given in Table 201.\*

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\* PL. XLIV, Fig. 3.

TABLE 201.

MEASUREMENT OF 35 FRUITS (NOS. 10819-10853) OF THE ŌSUGI WASE FROM  
TSUKUMI, KITAAMABE-GUN, ŌITA PREFECTURE. LOT NO. 195 OF 1928.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.03 cm.	4.95 cm.	1.33	111.71 gm.	10.77 mm.	10.09	2.97 mm.	13.91 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	35	—	—	—	—	—	0	% 0
Sinuate based fruits	35	—	—	—	—	—	16	45.71
Semi-sinuate based fruits	35	—	—	—	—	—	3	8.57
Areolated fruits	35	—	—	—	—	—	4	11.43
Frs. with undeveloped calyx lobes	35	—	—	—	—	—	7	20.00
Frs. with long narrow calyx lobes	35	—	—	—	—	—	2	5.71
Fruits containing seeds	34	—	—	—	—	—	0	0
Apical depression	35	0 0	5 14.29	24 68.57	6 17.14%	—	—	—
Apical dots	35	13 37.14	21 60.00	1 2.86%	—	—	—	—
Flatness of fruit	35	16 45.71	6 17.14	8 22.86	4 11.43	1 2.86%	—	—
Smoothness of fruit	35	0 0	35 100.00	0 0	0 0	0 0%	—	—
Thinness of rind	34	11 32.35	11 32.35	11 32.35	0 0	1 2.94%	—	—
Thinness of segment wall	34	7 20.59	15 44.12	10 32.41	2 5.88	0 0%	—	—
Color of pulp	34	25 73.53	9 26.47	0 0	0 0	0 0%	—	—
Size of central column	34	2 5.88	9 26.47	22 64.71	1 2.94	0 0%	—	—
Quantity of pulp	34	0 0	13 38.24	20 58.82	1 2.94	0 0%	—	—
Quality of pulp	31	31 100.00	0 0	0 0	0 0	0 0%	—	—



## FRUITS FROM THE NORMAL PART OF THE ÔSUGI WASE TREE

A lot of 35 fruits from the normal part of the original bud variation tree of the ÔSUGI Wase Satsuma was received from Mr. Sashirô MIYAMOTO of the Tsukumi Village Office, in December, 1926. These fruits are described as follows:

Fruits medium to small, regularly graded, outline regular, roundish oblate, rarely conical (No. 10880), or flat, good-looking. Apex shallowly concave in a small area, dots often lacking around the styler point, areola not common, navels all closed. Base usually rounded, always sinuous at the stem-end, no grooves, but sometimes with sharp, short furrows. Calyx decidedly small, thin, lobes very frequently not developed; disk entirely closed under the calyx. Surface fairly even, not strongly foveolate, often with equally distributed, convex oil cell dots, very well colored, compact. This is the Zairai variety, having a rounded base, small button, and rather tall and less depressed ends.

Cross-section: Rind medium-thin to medium, texture rather compact and not porous, more or less adherent to the segments. Wall rather thick, but fairly thin in many fruits. Central column medium to medium-large, rarely small; pith medium in quantity, rather solid and adherent to the segments. Segments uniform in size, rather broad, not many in number, corners rounded, inner ends also rounded. Pulp deep-colored (dark-colored, not bright), intensely flavored, generally of good quality, but hard and not melting. Vesiculation quite indistinct, somewhat coarse-grained, not visible, generally quite parallel in arrangement; fruit sometimes seedy. This is a pretty good Zairai with uniformly depressed globose outline, and hard, intensely flavored pulp.

The measurements of these fruits are given in Table 202.\*

## ICHIKAWA WASE FROM OKITSU, SHIDZUOKA PREFECTURE

On visiting the Imperial Horticultural Experiment Station at Okitsu, the author heard of the existence of the Ichikawa Wase from the staff.

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\* PL. XLV, Fig. 1.

TABLE. 202.

MEASUREMENT OF 35 FRUITS (NOS. 19854-19888) FROM THE NORMAL PART  
OF OSUGI'S BUD VARIATION TREE AT TSUKUMI, ÔITA  
PREFECTURE. LOT NO. 196 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.45 cm.	4.55 cm.	1.29	80.26 gm.	9.43 mm.	10.63	2.79 mm.	11.99 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	35	—	—	—	—	—	0	% 0
Sinuate based fruits	35	—	—	—	—	—	25	71.43
Semi-sinuate based fruits	35	—	—	—	—	—	9	25.71
Areolated fruits	35	—	—	—	—	—	13	37.14
Frs. with undeveloped calyx lobes	35	—	—	—	—	—	14	40.00
Frs. with long narrow calyx lobes	35	—	—	—	—	—	3	8.57
Fruits containing seeds	35	—	—	—	—	—	3	8.57
Apical depression	35	0 0	9 25.71	25 71.43	1 2.86%	—	—	—
Apical dots	35	13 37.14	18 51.43	4 11.43%	—	—	—	—
Flatness of fruit	35	2 5.71	7 20.00	19 54.29	6 17.14	1 2.86%	—	—
Smoothness of fruit	35	0 0	27 77.14	7 20.00	1 2.86	0 0%	—	—
Thinness of rind	35	9 25.71	15 42.86	9 25.71	2 5.71	0 0%	—	—
Thinness of segment wall	35	25 71.43	6 17.14	3 8.57	1 2.86	0 0%	—	—
Color of pulp	35	33 94.29	2 5.71	0 0	0 0	0 0%	—	—
Size of central column	35	0 0	9 25.71	21 60.00	4 11.43	1 2.06%	—	—
Quantity of pith	35	0 0	3 8.57	24 68.57	8 22.86	0 0%	—	—
Quality of pulp	35	30 85.71	3 8.57	2 5.71	0 0	0 0%	—	—

Through communication, it was learned that the owner, Mr. Chûsaku ICHIKAWA, at Seikenji, Okitsu-chô, Iwara-gun, Shidzuoka-ken, had been propagating the variation, though the original bud mutant is now lost. The following note was taken from his statement :

The orchard is facing the S-S-W and the original tree was located in about the middle of the plot: second generation trees are now scattered around the whole orchard. The original tree was about 4.3 m. high, grafted on sour stock. The variation branch was located at the north side of the tree at about 2 m. from the ground, gradually turning to the southward, having a length of about 1.15 m. The variation branch was cut down in 1911, when the fluted scale (*Icerya purchasi*) was found infecting the orchard. The whole orchard is about 2 hectars (chô) and slopes about 15°; the soil is clayey loam, mulched with straw. Fertilizers consist of dried herring, rape seed cake, soy bean cake, sulphate of ammonia, potassium sulphate, bone dust, rice bran, etc. applied in February or March, and again after the crop, liquid manure is given. The removal of weeds in summer, and ploughing in winter are practiced, and lime is added every two years. The variation was found by Chûjirô ICHIKAWA, father of the present owner, and the plant itself was propagated by him from buds taken from a tree from there, probably the Owari variety. The second generation trees started bearing from about 1909. They were all propagated by the same person.

A lot of 51 fruits was sent to the writer through the acting director of the Okitsu Horticultural Experiment Station, Dr. Keizô NAGAI. The description of these fruits are given below :

Fruits uniformly medium-sized, ranging from medium-large to medium-small, none very large nor very small. Shape depressed globose, slightly varying, rather rectangular, about 10% tall, and about 5% flat, none being conical nor with projecting base. Apex not very depressed, generally with large naked area around the styler point. Navel usually prominent, often sticking out. Areola generally present. Base rounded, slightly depressed at the stem-end or simply flat. Calyx large, with well developed lobes which are sometimes very elongated or abnormally shortened. Disk generally prominent, often broadened; double-ring very

common ; some have a naked area around the disk, not forming a double-ring ; radial striations also very pronounced, and sharp, deep furrows often present. Surface well-colored, even but not very smooth, often slightly pitted (may be due to a late pick) ; oil cell dots large but not very large, equal low pustulate, but not very prominent.

Cross-section : Rind uniformly thin, more or less brittle, some becoming loose, due to the pressure received during transit. Segment wall rather thick and white, showing slight deterioration. Central column not small and generally conspicuously large, filled with white, dense pith. Segments rather irregular in shape. Pulp deep-colored, sometimes slightly faded, flavor not very good, but moderately fair in quality : many have sourish taste, caused perhaps by too much pressure of packing and deterioration during storage. Vesiculation distinct, occasionally very clear, coarse but somewhat elongated, not short anastomose, although more or less broad in some segments. According to Mr. Toshiyoshi TANIKAWA of the Okitsu Station, the quality of this strain is inferior to Kawano Wase after a trial of many years.

The measurements of these fruits are given in Table 203.\*

There is a second generation tree about 5 years old in the orchard of the Imperial Horticultural Experiment Station at Okitsu. It bears typical fruits and large, boat-shaped leaves. Two fruits collected from this tree are described as follows :

Fruits flat, extremely polished. Apex very flat, with large naked area around the styler point, areola present, navel strongly marked and sticking out. Base flat, often double-ringed around the calyx ; disk broad without a definite margin, and with fine radial striations. Surface more advanced in coloring than in the Owari fruits found near the tree, but still green all over (on Oct. 25, 1926) : oil cell dots very large, especially so at the apex. Cross-section : Rind thin, oil cells well apart, wall rather thin, central column medium-small, and pith much. Segments rather irregular. Pulp tastes medium to subacid, is not sweet enough as

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\* PL XLV, Fig. 2

TABLE 203.

MEASUREMENT OF 51 FRUITS (NOS. 10910-10960) FROM SECOND GENERATION  
TREES OF THE ICHIKAWA WASE FROM OKITSU, SHIDZUOKA  
PREFECTURE. LOT NO. 199 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
20.58 cm.	4.94 cm.	1.33	110.39 gm.	11.10 mm.	10.41	2.30 mm.	13.64 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	51	—	—	—	—	—	24	47.06%
Sinuate based fruits	51	—	—	—	—	—	8	15.69
Semi-sinuate based fruits	51	—	—	—	—	—	0	0
Areolated fruits	51	—	—	—	—	—	32	62.75
Frs. with undeveloped calyx lobes	51	—	—	—	—	—	6	11.76
Frs. with long narrow calyx lobes	51	—	—	—	—	—	7	13.73
Fruits containing seeds	51	—	—	—	—	—	0	0
Apical depression	51	0 0	6 11.76	37 72.55	8 15.69%	—	—	—
Apical dots	51	32 62.75	19 37.25	0 0%	—	—	—	—
Flatness of fruit	51	4 7.84	9 17.65	25 49.02	9 17.65	4 7.84%	—	—
Smoothness of fruit	51	0 0	49 96.08	2 3.92	0 0	0 0%	—	—
Thinness of rind	51	35 68.63	13 25.49	3 5.88	0 0	0 0%	—	—
Thinness of segment wall	51	21 41.18	17 33.33	12 23.53	1 1.96	0 0%	—	—
Color of pulp	51	36 70.59	14 27.45	1 1.96	0 0	0 0%	—	—
Size of central column	51	1 1.96	13 25.49	33 64.71	3 5.88	1 1.96%	—	—
Quantity of pith	51	2 3.92	23 45.10	24 47.06	1 1.96	1 1.96%	—	—
Quality of pulp	47	21 44.58	14 29.79	4 8.51	8 17.02	0 0%	—	—

yet, though not insipid. The measurements of these two fruits are as follows :

	Girth	Diameter	Height	Calyx	Navel	No. Segm'ts.	Rind	Center	Seed
No. 1	21.0 cm.	6.6 cm.	5.3 cm.	14 mm.	closed	10	mm. 1.5-2	13x9 mm	0
No. 2	20.8	6.5	4.7	10	open	11	1-2	15x12	0

### UENO WASE, FOUND IN WAKAYAMA PREFECTURE

At the request of Mr. Sukesaburô IZEKI of Wakayama Prefecture, Dr. SWINGLE and the writer visited him to see a new Wase strain which he had been watching for several years. The original plant died in 1921 but the stump of the tree remained when the study was made (PL. LIII, Fig. 9). This is located in an orchard on a slight slope, being the fifth tree from the east on the row below a parallel horizontal path. The orchard now belongs to Kôkichi KUBO, Arami, Ryûmon-mura, Naka-gun, Wakayama-ken, but the variation was discovered by the previous owner, Kwan'ichi UENO, after whom the plant was named by the writer<sup>(175)</sup>.

The original dead plant has a girth of 40 cm. on the raised root part, and 25 cm. above the union. Two side branches arise at almost the same place from about 30 cm. from the ground, the western branch of which is said to have been Wase. Mr. IZEKI remarked that the plant was an Ikeda variety about 30 years old having a flat top. The variation branch was bearing fruits in thick clusters, which fruits were small and round with rather rough and thick skin, lacking juice and sweetness. It is said that Mr. UENO used to protect the fruits by covering the whole plant with straw, because they were attractive and so subject to pick without consent. Mr. KUBO propagated this plant in his orchard in 1921, and in the fall the original plant died. The orchard has poor soil, with a cover crop of *Astragalus sinicus*, fertilized with 4 kwan (15 kg.) of nitrogen, 4.5 kwan (16.875 kg.) of phosphoric acid, and 2 kwan (7.5 kg.) of potash per tan (9.9 ares). The trees in the same orchard are all equal in looks, of the Ikeda variety, with small, upright, pointed, deep-colored leaves,

and round, much-pitted, hard, green-colored fruits maturing from the 10th to 20th of December. The top-worked second generation tree in Mr. KUBO's garden, surrounded by bamboo groves, is a poor-looking small tree grafted on to Natsu-daidai. It is a flat tree of small size with the typical lozenge-shaped leaf. The fruits left on the tree were smooth, with large pointed calyx lobes and the stylar end without naked area. All fruits had a rather severe infection of sour-scab. The average fruits were small, flat, dots not prominent, very smooth though scabby. Color decidedly more advanced than the Ikeda fruits nearby, turgid and normal.

A fruit picked from this plant is described as follows (studied on Oct. 10, 1926):

Fruit small, 16.1 cm. in girth, 5.0 cm. in diameter, and 4.0 cm. in height; medium-flat in shape. Apex flattened, dots reaching to the stylar point, and navel is open. Base more or less sinuous; calyx large, lobes long, pointed. Surface smooth, color light orange, still somewhat greenish; oil cell dots rather close. Cross-section: Rind thin, 2-2.5 mm., segment wall also thin, central column medium-small, measuring  $10 \times 7$  mm. and the pith medium in quantity. Segments 11, rather uniform. Pulp medium-good in taste, vesiculation decidedly coarse-grained and reticulate. No seed.

Four late pick fruits of the *Ueno Wase* (Nos. 10990-10993) were sent later by Mr. IZEKI. Although these were not good material for study, they are described below:

Fruits very small (cull) except one (No. 10990), depressed globose, more or less flat, sometimes very flat. Apex only shallowly depressed, rarely areolate, dots reaching to the stylar point, navel open in the large fruit. Base flat or sinuous; calyx large, well lobed, lobes being broad and bird-wing shaped; disk large and exposed or rather small and covered. Surface smooth, good-colored, pitted in large fruit, but oil cell dots are all convex in smaller ones. Infection of sour-scab very severe.

Cross-section: Rind medium to thin, soft, more or less porous and brittle. Segment wall thin, soft and tenacious. Central column medium to small, with little pith. Segments with not very rounded corners and

TABLE 204.

MEASUREMENT OF 4 LATE PICK FRUITS (NOS. 10990-10993) OF THE UENO  
WASE FROM RYÛMON-MURA, NAKA-GUN, WAKAYAMA  
PREFECTURE. LOT NO. 201 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
15.60 cm.	3.53 cm.	1.41	47.00 gm.	11.50 mm.	10.00	2.50 mm.	9.60 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	4	—	—	—	—	1	25.00
Sinuate based fruits	4	—	—	—	—	2	50.00
Semi-sinuate based fruits	4	—	—	—	—	0	0
Areolated fruits	4	—	—	—	—	1	25.00
Frs. with undeveloped calyx lobes	4	—	—	—	—	0	0
Frs. with long narrow calyx lobes	4	—	—	—	—	0	0
Fruits containing seeds	4	—	—	—	—	0	0
Apical depression	4	0 0	1 25.00	3 75.00	0 0%	—	—
Apical dots	4	0 0	1 25.00	3 75.00%	—	—	—
Flatness of fruit	4	1 25.00	2 50.00	0 0	1 25.00	0 0%	—
Smoothness of fruit	4	0 0	4 100.00	0 0	0 0	0 0%	—
Thinness of rind	4	1 25.00	1 25.00	2 50.00	0 0	0 0%	—
Thinness of segment wall	4	3 75.00	1 25.00	0 0	0 0	0 0%	—
Color of pulp	4	4 100.00	0 0	0 0	0 0	0 0%	—
Size of central column	4	0 0	0 0	2 5.000	0 0	2 50.00%	—
Quantity of pith	4	0 0	0 0	0 0	3 75.00	1 25.00%	—
Quality of pulp	4	4 100.00	0 0	0 0	0 0	0 0%	—



obtuse or chisel-pointed inner ends. Pulp deep-colored and almost reddish, meaty, extremely sweet and of good quality, not turning acidulous in the over-ripe condition (kept until Jan. 8, 1927). Vesiculation decidedly round-netted, not elongated. The Wase character is very distinct, the character of pulp appears to be good. The size of the fruit may have been better in the first pick and the condition of the tree may favor an increase in the size. Infection of sour-scab is perhaps another factor which reduced the size of the fruits.

The measurements of these four fruits are given in Table 204.\*

### **NORMAL IKEDA FRUIT AT KUBO'S ORCHARD, WAKAYAMA PREFECTURE**

Twenty-nine Ikeda fruits were sent from a tree in Mr. KUBO's orchard where the original tree of Ueno Wase was found. The description of these fruits is given below :

Fruits medium to small, outline regular. Apex shallowly concave in a small area, dots mostly reaching to the styler point, areolate, navels very few. Base well rounded, some slightly conical, stem-end sinuous, sometimes flattened, not furrowed. Calyx normal, often enlarged and surrounded by fine radial striations like Wase, sometimes double-ringed. Surface hard, pitted, deep, dirty orange color ; oil cell dots very fine, not convex.

Cross-section : Rind considerably thick, but not very thick in the largest fruits, hard, elastic, not porous. Segment wall uniformly thin and strong. Central column rather small, pith little, at least not very much. Segments fairly uniform in size, number variable, outer corners not very rounded, inner ends rather pointed. Pulp very deep-colored, intensely flavored, sweetness sufficient, acidity suppressed. On Jan. 8th., pulp slightly changed in flavor, and on Jan. 30th, fruit had still kept wonderfully well without any shrinkage of the segments, despite the fact that the fruits had arrived in a bad condition. Remarkable keeping quality (typical of Ikeda). Rot was very little during storage. Pulp vesicles few

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\* PL. XLV, Fig. 3.

TABLE 205.

MEASUREMENT OF 29 FRUITS (NOS. 10961-10989) OF AN IKEDA TREE GROWN  
IN THE ORCHARD WITH THE ORIGINAL PLANT OF THE  
UENO WASE. LOT NO. 200 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.05 cm.	4.45 cm.	1.28	74.86 gm.	10.85 mm.	10.64	3.18 mm.	9.10 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	29	—	—	—	—	—	4	13.79%
Sinuate based fruits	29	—	—	—	—	—	22	75.86
Semi-sinuate based fruits	29	—	—	—	—	—	0	0
Areolated fruits	29	—	—	—	—	—	26	89.66
Frs. with undeveloped calyx lobes	29	—	—	—	—	—	7	24.14
Frs. with long narrow calyx lobes	29	—	—	—	—	—	1	3.45
Fruits containing seeds	29	—	—	—	—	—	0	0
Apical depression	29	0 0	3 10.34	26 89.66	0 0%	—	—	—
Apical dots	29	0 0	9 31.03	20 68.97%	—	—	—	—
Flatness of fruit	29	0 0	3 10.34	15 51.72	10 34.48	1 3.45%	—	—
Smoothness of fruit	29	0 0	2 6.90	20 68.97	5 17.24	2 6.90%	—	—
Thinness of rind	29	0 0	4 13.79	16 55.17	5 17.24	4 13.79%	—	—
Thinness of segment wall	29	25 86.21	4 13.79	0 0	0 0	0 0%	—	—
Color of pulp	29	29 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	29	0 0	1 3.45	6 20.69	13 44.83	9 31.03%	—	—
Quantity of pith	29	0 0	0 0	10 34.48	14 48.28	5 17.24%	—	—
Quality of pulp	28	22 78.57	4 14.29	2 7.14	0 0	0 0%	—	—

in number, wall almost invisible, looking like one mass, vesiculation decidedly elongate-netted. This is a distinct Ikeda with very thick rind, thin segment wall and intensely flavored pulp which keeps well.

The measurements of these fruits are given in Table 205.\*

### KUBO WASE, ANOTHER NEW WASE FROM WAKAYAMA PREFECTURE

In the same season, 1926, Mr. IZEKI discovered another bud variation Wase Satsuma as a result of the author's encouragement. The following note is based upon a communication by Mr. IZEKI who took the trouble to prepare it for the author.

The plant is located at the TOSAKAO orchard of Mr. KUBO, in Arami, Ryûmon-mura, Naka-gun, Wakayama-ken. It is in the center of a cliff, facing the north-east, and is an Ikeda tree 55 years after being planted. The spread of the tree is 2.3 m. by 2 m. and the height is 2.9 m. The appearance of the tree resembles those near the original stump of Ueno Wase, but being sick and weak, the leaves are more narrow and pointed. The variation branch was on the eastern side of the tree, but the whole branch was cut and sent to the writer. The soil is gravel loam, the slope gradual, green manure of *Astragalus sinicus*, bone dust, tankage, wood ash, etc. are applied and ploughed under in June and July. The variation was found by Mr. IZEKI on Nov. 23, 1926.

Description of six fruits received with the branch are described as follows :

Fruits rather small, roundish or tall, depressed globose, both ends rounded, not distinctly concave. Apex very slightly depressed, with naked, smooth area around the styler point. Areola present, navel closed. Base slightly sinuous at the stem end. Calyx not large, lobes also not large, not well developed. Disk more or less large and rather well marked : radial grooves absent, radial striations more or less distinct. Surface smooth, shiny, bright reddish in coloring ; oil cell dots large and set a part, not very prominent. General appearance very much like Ikeda, as

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\* PL. XLV, Fig. 4.

TABLE 206.

MEASUREMENT OF 6 FRUITS (NOS. 10711-10716) OF THE KUBO WASE FROM  
RYÛMON-MURA, NAKA-GUN, WAKAYAMA PREFECTURE.  
LOT NO. 185 OF 1926.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.40 cm.	4.60 cm.	1.25	82.83 gm.	10.00 mm.	10.50	2.50 mm.	11.33 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	6	—	—	—	—	—	1	% 16.67
Sinuate based fruits	6	—	—	—	—	—	3	50.00
Semi-sinuate based fruits	6	—	—	—	—	—	0	0
Areolated fruits	6	—	—	—	—	—	6	100.00
Frs. with undeveloped calyx lobes	6	—	—	—	—	—	1	16.67
Frs. with long narrow calyx lobes	6	—	—	—	—	—	0	0
Fruits containing seeds	6	—	—	—	—	—	0	0
Apical depression	6	0 0	0 0	6 100.00	0 0%	—	—	—
Apical dots	6	4 66.67	2 33.33	0 0%	—	—	—	—
Flatness of fruit	6	0 0	0 0	2 33.33	4 66.67	0 0%	—	—
Smoothness of fruit	6	2 33.33	4 66.67	0 0	0 0	0 0%	—	—
Thinness of rind	6	6 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	6	4 66.67	2 33.33	0 0	0 0	0 0%	—	—
Color of pulp	6	6 100.00	0 0	0 0	0 0	0 0%	—	—
Size of central column	6	0 0	0 0	5 83.33	1 16.67	0 0%	—	—
Quantity of pith	6	0 0	3 50.00	3 50.00	0 0	0 0%	—	—
Quality of pulp	6	3 50.00	3 50.00	0 0	0 0	0 0%	—	—

the fruit has a peculiar lustre and shape, but is decidedly smoother, and has a characteristic apical naked area.

Cross-section: Rind thin, absolutely not Ikeda, segment wall moderately thin. Central column smaller than medium, with much pith. Segment rather, pulp deep-colored, very juicy and of excellent flavor, some slightly acidulous due to being over-ripe. Vesiculation visible but not thick walled, conspicuously coarse-grained, typical of Wase.

This is unquestionably a case of bud variation but unfortunately the branch was cut down and sent with the cluster of fruit. The stick was, however, saved for propagation.

The measurements of these fruits are given in Table 206.\*

### **MATSUKI'S GIANT-FRUITING VARIATION BRANCH IN SHIDZUOKA PREFECTURE**

On visiting the Imperial Horticultural Experiment Station at Okitsu, in October, 1926, the writer was informed by Mr. Ikurō TAKAHASHI of the station, that MATSUKI's giant-fruited branch found at Tegoshi, Osada-mura, Abe-gun, Shidzuoka-ken, is a case of bud variation, because it was propagated through vegetative propagation. A second generation tree planted at the Okitsu Station was bearing fruit of a large size, pitted very deeply, dark green in color, with more or less conical base and large calyx attached to a thick stem, having no naked area around the styler point. The leaves on this young plant looked somewhat curled, very boat-shaped, not showing any characteristics of Wase. Mr. TAKAHASHI observed the tree in the spring of 1926 and desired to investigate the fruit in the fall, but the owner brought that nursery plant, instead of bringing the fruits with an apology, saying that he had removed all fruits on account of a severe affection of red spider.

The plant has been known since 1914, and a good illustration of the gigantic fruits was published<sup>(46b)</sup>. The writer saw the plant in 1920 and made a critical study of the habit of the branch and the crop on it and he decided it was a temporary change and not a case of bud

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\* PL. XLV, Fig. 5.

variation, hence the account was never published. Admitting the statement of Mr. TAKAHASHI and a recent observer<sup>(216)</sup>, the plant and its products are here described as Wase. This was published by the author<sup>(175)</sup> under the name "Matsuki Wase," based upon Mr. TAKAHASHI's statement given by the owner that the fruit matures at a time between that of Kawano Wase and Owari.

The plant is by the house of Kinzô MATSUKI, on level land facing the east, at 7 m. from the central path through the tea plants near the neighbor's house (PL. LIII, Fig. 10 and 10<sup>a</sup>). It is a large tree planted in about 1850, having a diameter of 6.2 m. in E-W spread, 6.7 m. in N-S spread and a height of 3.7 m. The girth of the trunk is 1.08 m., being very short, having two large side stems and one upright stem, the girth of which are 42 cm., 37 cm., and 58 cm., respectively, at 30 cm. from the ground. The last immediately divides into two and the northern stem has two small accessory limbs coming out from the lowermost part. One of these limbs spreads horizontally, and the other, ascending upwards, reaches to an enormously swollen portion at 2.8 m. from the root, measured along the limb. Above the swelling, fruits of an enormous size are borne. The appearance of the tree is rather weak, and the leaves are rather slender, hanging, more or less mottled and buckled. The leaves above the swelling are larger, moderately hanging, slightly boat-shaped, and loose, never crowded. The way the abnormal swelling was formed is not known but it is a very large knob three times as thick as the branch below, and four branches arises from it, one of which looks nearly as thick as the branch below. The plant came as a nursery plant from Mariko of the same prefecture, and it was set in by the owner's grandfather, Iemon MATSUKI. The large fruiting was first found about 1908, and the sweeter taste was admitted by everybody who tasted the fruit, but the maturing season was not earlier than the others.\* The soil is pebbled loam rich in organic matter. Dried herring is applied

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\* The owner informed the writer in 1920 that the fruit does not mature any earlier than other Owari fruits, so that Mr. TAKAHASHI's statement, said to have been obtained from the owner, must be based on later experience. He did not have any plant of Kawano Wase in 1920.

in the spring at the ratio of 2.5 shô (4.5 litres) per tree in addition to two barrels of manure. Heavy mulching of organic matter is also applied.

The description of six fruits borne on one of the branches above the swollen part is as follows :

Fruits more or less flattened, baggy or hard. Apex broadly depressed, almost always with shallow but long radial grooves. Areola, if present, indistinct and discontinuous, but the apical part projects above the areola region in fruit No. 1679. Navel sometimes open. Base always depressed, often deeply concave, grooves distinct and strong, one fruit (No. 1679) has a very distinct triple ring around the stem-end. Stem very thick and strong but calyx always small, and tube part almost none, 5 triangular sepals appearing attached to the stem. Surface almost well colored, roughened primarily by the convexity of dots, but fovea also present. Oil cell dots large, apart, either convex or concave. Every fruit has an enormous size, the largest one being 9.7 cm. in diameter.

Cross-section : Rind thick, oil cells in one row, goblet-shaped,  $3 \times 2$  mm. in size, white inner layer twice as thick as the oil cell layer, sometimes having a space between the pulp ball. Segment wall not very thick, not much whitened, cartilaginous layer being prominent, very easily separable. Central column not large in proportion to the size of the pulp ball, pith also not very much in comparison with the amount of rind-rag. Segments very large, outer ends rounded, slightly emarginated, inner ends more or less indistinctly mamillate, sometimes a few segments are fastened by the rag at the center. Pulp deep salmon colored (reddish), often discolored, rather hard and scanty of juice, sweetish, insipid. Vesiculation very distinct, very coarse-grained. Individual vesicles nearly free, very much loosened, wall most clearly seen by the whitening, hard and often nearly juiceless.

The enlargement in the size of the fruit seems not to affect the increase in the number of segments, of oil cells and of pulp vesicles.

To compare these with the normal fruits of the same tree, two fruits just below the swollen part, and 48 fruits from a branch farther below were studied. The description of these fruits is :

Fruits rather large-sized, shape medium to medium-flat, rarely

TABLE 207.

MEASUREMENT OF 6 GIANT FRUITS (NOS. 1675-1680) FROM A BRANCH ABOVE  
THE SWOLLEN PART OF MATSUKI'S TREE AT MARIKO,  
SHIDZUOKA PREF. LOT. NO. 44 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
30.40 cm.	7.31 cm.	1.34	281.33 gm.	13.50 mm.	10.33	6.29 mm.	21.33 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	6	—	—	—	—	—	2	33.33%
Sinuate based fruits	6	—	—	—	—	—	2	33.33
Semi-sinuate based fruits	6	—	—	—	—	—	1	16.67
Areolated fruits	6	—	—	—	—	—	3	50.00
Frs. with undeveloped calyx lobes	6	—	—	—	—	—	3	50.00
Frs. with long narrow calyx lobes	6	—	—	—	—	—	0	0
Fruits containing seeds	6	—	—	—	—	—	0	0
Apical depression	6	$\frac{5}{83.33}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{1}{16.67\%}$	—	—	—
Apical dots	6	$\frac{0}{0}$	$\frac{1}{16.67}$	$\frac{5}{83.33\%}$	—	—	—	—
Flatness of fruit	6	$\frac{1}{16.67}$	$\frac{3}{50.00}$	$\frac{2}{33.33}$	$\frac{0}{0}$	$\frac{0}{0\%}$	—	—
Smoothness of fruit	6	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{2}{33.33}$	$\frac{2}{33.33}$	$\frac{2}{33.33\%}$	—	—
Thinness of rind	6	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{1}{16.67}$	$\frac{5}{83.33\%}$	—	—
Thinness of segment wall	6	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{4}{66.67}$	$\frac{1}{16.67}$	$\frac{1}{16.67\%}$	—	—
Color of pulp	6	$\frac{5}{83.33}$	$\frac{1}{16.67}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0\%}$	—	—
Size of central column	6	$\frac{0}{0}$	$\frac{1}{16.67}$	$\frac{3}{50.00}$	$\frac{2}{33.33}$	$\frac{0}{0\%}$	—	—
Quantity of pith	6	$\frac{0}{0}$	$\frac{2}{33.33}$	$\frac{4}{66.67}$	$\frac{0}{0}$	$\frac{0}{0\%}$	—	—
Quality of pulp	6	$\frac{4}{66.67}$	$\frac{2}{33.33}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0\%}$	—	—



TABLE 208.

MEASUREMENT OF 2 FRUITS (NOS. 1681, 1632) FROM THE NORMAL PART OF A  
BRANCH BELOW THE SWELLING OF THE MATSUKI WASE TREE IN  
SHIDZUOKA PREFECTURE, LOT NO. 43 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
19.50 cm.	4.65 cm.	1.34	89.00 gm.	9.00 mm.	10.50	2.25 mm.	14.25 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	2	—	—	—	—	—	0	0
Sinuate based fruits	2	—	—	—	—	—	1	50.00
Semi-sinuate based fruits	2	—	—	—	—	—	1	50.00
Areolated fruits	2	—	—	—	—	—	0	0
Frs. with undeveloped calyx lobes	2	—	—	—	—	—	2	100.00
Frs. with long narrow calyx lobes	2	—	—	—	—	—	0	0
Fruits containing seeds	2	—	—	—	—	—	1	50.00
Apical depression	2	1 50.00	1 50.00	0 0	0 0%	—	—	—
Apical dots	2	0 0	0 0	2 100.00%	—	—	—	—
Flatness of fruit	2	0 0	1 50.00	1 50.00	0 0	0 0%	—	—
Smoothness of fruit	2	0 0	1 50.00	1 50.00	0 0	0 0%	—	—
Thinness of rind	2	2 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	2	0 0	1 50.00	1 50.00	0 0	0 0%	—	—
Color of pulp	2	1 50.00	1 50.00	0 0	0 0	0 0%	—	—
Size of central column	2	0 0	0 0	2 100.00	0 0	0 0%	—	—
Quantity of pith	2	0 0	1 50.00	0 0	1 50.00	0 0%	—	—
Quality of pulp	2	0 0	1 50.00	0 0	0 0	1 50.00%	—	—

TABLE 209.

MEASUREMENT OF 48 OWARI FRUITS (NOS. 1683-1730) FROM A NORMAL  
BRANCH OF THE TREE PRODUCING GIANT FRUITS (MATSUKI  
WASE). LOT NO. 42 OF 1920.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
21.20 cm.	5.11 cm.	1.32	113.52 gm.	9.29 mm.	10.42	4.86 mm.	19.28 mm.

No. of fruits examined	Class					Total	
	1	2	3	4	5		
Naveled fruits	48	—	—	—	—	6	12.50
Sinuate based fruits	48	—	—	—	—	29	60.42
Semi-sinuate based fruits	48	—	—	—	—	16	33.33
Areolated fruits	48	—	—	—	—	15	31.25
Frs. with undeveloped calyx lobes	48	—	—	—	—	24	50.00
Frs. with long narrow calyx lobes	48	—	—	—	—	1	2.08
Fruits containing seeds	48	—	—	—	—	6	12.50
Apical depression	48	15 31.25	22 45.83	9 18.75	2 4.17%	—	—
Apical dots	48	0 0	5 10.42	43 89.58%	—	—	—
Flatness of fruit	48	0 0	9 18.75	31 64.58	8 16.67	0 0%	—
Smoothness of fruit	48	0 0	2 4.17	38 79.17	6 12.50	2 4.17%	—
Thinness of rind	48	1 2.08	7 14.58	20 41.67	17 35.42	3 6.25%	—
Thinness of segment wall	48	2 4.17	22 45.83	17 35.42	7 14.58	0 0%	—
Color of pulp	48	31 64.58	17 35.42	0 0	0 0	0 0%	—
Size of central column	48	0 0	6 12.50	26 54.17	16 33.33	0 0%	—
Quantity of pith	48	0 0	6 12.50	31 64.58	11 22.92	0 0%	—
Quality of pulp	48	20 41.67	18 37.50	10 20.83	0 0	0 0%	—

conical. Outline regular, base rather deeply sinuous, generally grooved. Calyx small, lobes well developed and not thin. Apex broadly depressed, areola sometimes present; navel not prominent. Fruit in almost full maturity, tight-skinned, blemishes limited to cases of scale insect attack, soot, and thrips. Picked on November 29, 1920.

Cross-section: Rind thick, oil cells crowded and in two rows, rarely somewhat baggy. Segment wall medium-thin, outer corner more or less angular, inner end very pointed, often two or three segments are fastened at the inner end by pith, which is medium in quantity and rather scanty. Pulp deep-colored, juicy, tasting remarkably good, just fully ripe. Vesiculation rather fine, more or less salmon-flesh structure.

From this comparison, it is known that the essential characters of the giant fruit seem not very different from the normal fruits although the maturity of the former is a little advanced, as shown by the fact that the juice is almost lost and there is acidity. The vesicle arrangement is not very different, as seen in the comparison of both kinds of fruits. The abnormality of the characters due to the enormous enlargement of the fruit makes it difficult to judge whether they are all constant or not. It was first thought the gigantism was temporarily caused by a kind of ringing effect inaugurated at the swelling part, every character being simply an enlargement of the Owari characters which are usually possessed by normal fruits. At any rate, it is quite abnormal for a Wase fruit to have such a thick rind, large central column, much depressed apex, flat outline, etc.

The measurements of these fruits are given in Tables 207,\* 208,\*\* and 209.\*\*\*

### **KODAMA WASE?, SENT BY MR. TOGASHI OF THE KANAGAWA EXPERIMENT STATION**

Among many different lots of Satsuma fruits sent by the author's collaborators for identification, this was chosen as a case of discovery of

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\* PL. VLVI, Fig. 1.

\*\* PL. XLVI, Fig. 2.

\*\*\*PL XLVI, Fig. 3.

Wase, but one lacking sufficient comparative materials and requiring later investigation to prove the validity of the identification.

One fruit was received from Mr. T. TOGASHI, director of the Horticultural Sub-station of the Kanagawa Agricultural Experiment Station, which was named "Kodama Wase" by him. The fruit was large-sized, 26.2 cm. in girth and 7.7 mm. in height (D/H index 1.08), of extremely tall and conical shape. Apex concave, having large areola, naked area around the styler point and closed navel. Stem-end sinuous, deeply grooved; calyx small, rather flat, lobes regular, acute, stem not large. Surface more or less pitted and roughened, bright-colored, color reddish, without rind or striations around the calyx. Oil cell dots large, convex and set apart. Cross-section: Rind very thick with large oil cells, 4, 5-6 mm., wall also thick, central column more or less large, 25 mm. across, with much pith. Segments 10; pulp deep-colored but discolored, sweet and insipid. No seed. It looks unquestionably like a Wase, but no definite remarks on the nature of the plant were given. Two short branches were also sent. Leaves on these shoots are not large but are rather slender with narrowed base and acuminate apex. Some leaves are rather conspicuously narrowed, some have a rather irregular outline and are asymmetrical, seeming rather variable. It is not known whether this is a case of bud variation or not.

Prior to this time, 22 fruits were sent by the same person for identification. These were straight Owari, and not Wase.

A similar shipment of fruits of a probable Wase mutation was made by Mr. Kanesuke HARA of the Shidzuoka Agricultural Society in 1924. This consisted of a very thick cluster of 11 large fruits having bright color and thin skin. As it was so attractive, Mr. HARA cut the bunch off and sent the whole cluster to the writer under the same "Ayakari mikan" (happy cluster, fruits of good luck). Judging from the mode of bearing and the appearance of fruits, this may have been a case of Wase mutation, but since the record of the plant was lost and the whole branch was removed, the true nature of this case was not sought.

As instanced by these examples, the search for the Wase mutation

is an endless task and the rise and fall of these individual mutants is a question of chance. Many true mutations must have been lost by unconscious pruning, or by an accidental cut as in the case of Kubo Wase and other examples. Further search for Wase mutations is thus left to local workers, like NAKAMURA,\* NORO,\* OKAMOTO,\*\* IZEKI,\*\* and others. The aim of the author in recording the earlier discoveries of Wase mutants was to inaugurate further surveys and experiment work, by which the true economic value of the author's findings will be advanced.

A few other mutations, originating Wase-like characters, are given in the following chapters.

### **YAMAMOTO HIRAMI SATSUMA, A FLAT VARIETY OF EARLY MATURITY**

In 1923, the writer's attention was called by the staff of the Kanagawa Agricultural Experiment Station to the existence of a flat-fruited strain originated through bud variation. The tree is owned by Sentarō YAMAMOTO No. 468 Kamigumi, Hayakawa-mura, Ashigarashimo-gun, Kanagawa-ken. The orchard is located at Kyōō Irikita, on a fairly steep slope facing south, partly destroyed by the earthquake of September 1923. The location of the tree is on the lowermost row, the second tree from the east. The distance between trees is 4 m. and the present plant is about 5.2 m. in spread in both directions and is 3.5 m. high. It is a round-headed plant with a very short, thick common trunk and many upright major branches arising very low, bearing many vigorous, upright shoots. The sport branch is found on the south-eastern side of the tree, quite high up from the ground, characterized by the very bushy, leafy appearance of the top. The total length of this branch is about 60 cm. The leaves on the other parts of the tree are large, upright, deep-colored, and rather crowded, and the fruits are generally flat. The leaves of the

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\* Works of these authors will be summarized later on.

\*\* These authors claim that they found several new strains of Wase, but none have been formally reported.

variation branch are much smaller, but do not show the characteristics of the common Wase. The tree was originally propagated by Katsujirô YAMAMOTO about 1902, and the scion came from the grove opposite the alley (PL. LIII, Fig. II). From about 1893, the Owari variety was brought from both Aichi and Idzumi Provinces, but the older trees were mostly Ikeda. The present tree appears to be one of the Owari trees which became popular about that time. The sport branch was discovered by the owner in 1906, and lately it was propagated by the horticulturists of the Kanagawa Agricultural Experiment Station for experimental purposes. The fruit of this branch is extremely flat, and colors about a week earlier than the earliest fruit of the other branches; it usually starts to color from the very flat stem-end. The tree is well fertilized; the soil is blackish volcanic loam and very fertile.

The description of the fruit is given below :

Fruits medium-sized, extremely flat with remarkable depression at both ends. There are broad, naked areas at both ends; at the calyx end, this area looks somewhat excavated, being entirely devoid of oil cell dots. Such an area is sometimes very large (No. 7210), measuring about 14 mm. in diameter. Fine radial oil cell streaks radiate from this area, but in case the area is small, such streaks are often seen coming out from the calyx. The dot-less area of the apex is also very large, sometimes measuring about 17 mm. in diameter (No. 7212). The stylar point forms a very large scar, rarely measuring about 8 mm. in diameter (No. 7210). Calyx is normal; disk is slightly enlarged. Surface of fruit is smooth and polished, showing segmental ridges on the outside. Oil cell dots large and distant. No navel is developed. Fully matured and well colored without blemishes. • (Picked on Nov. 4, 1923).

Cross-section : Rind thin with remarkable large oil cells. Segment wall thin. Segments rather large, with round outer ends, outer corners and inner ends. Central column extremely large with abundant pith. Pulp very light-colored, subacid or acidulous, of poor quality. Vesiculation fine, conspicuously reticulate; individual vesicles standing upright, especially at the central part of the segment.

TABLE 210.

MEASUREMENT OF 3 FRUITS (NOS. 7210-7212) OF YAMAMOTO HIRAMI  
SATSUMA FROM HAYAKAWA-MURA, ASHIGARASHIMO-GUN,  
KANAGAWA PREFECTURE. LOT NO. 98 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
17.67 cm.	3.23 cm.	1.76	54.00 gm.	9.33 mm.	10.67	2.25 mm.	14.17 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	3	—	—	—	—	—	0	% 0
Sinuate based fruits	3	—	—	—	—	—	0	0
Semi-sinuate based fruits	3	—	—	—	—	—	0	0
Areolated fruits	3	—	—	—	—	—	1	33.33
Frs. with undeveloped calyx lobes	3	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	3	—	—	—	—	—	0	0
Fruits containing seeds	3	—	—	—	—	—	0	0
Apical depression	3	3 100.00	0 0	0 0	0 0%	—	—	—
Apical dots	3	3 100.00	0 0	0 0%	—	—	—	—
Flatness of fruit	3	3 100.00	0 0	0 0	0 0	0 0%	—	—
Smoothness of fruit	3	3 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of rind	3	3 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	3	3 100.00	0 0	0 0	0 0	0 0%	—	—
Color of pulp	3	0 0	0 0	3 100.00	0 0	0 0%	—	—
Size of central column	3	0 0	3 100.00	0 0	0 0	0 0%	—	—
Quantity of pith	3	0 0	3 100.00	0 0	0 0	0 0%	—	—
Quality of pulp	3	0 0	0 0	2 66.67	1 33.33	0 0%	—	—

TABLE 211.

MEASUREMENT OF 11 FRUITS (NOS. 9047-9057) OF YAMAMOTO HIRAMI  
SATSUMA FROM HAYAKAWA-MURA, ASHIGARASHIMO-GUN.  
KANAGAWA-KEN. LOT NO. 133 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.68 cm.	3.00 cm.	1.77	47.45 gm.	9.00 mm.	10.64	2.38 mm.	13.31 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	11	—	—	—	—	—	4	% 36.36
Sinuate based fruits	11	—	—	—	—	—	0	0
Semi-sinuate based fruits	11	—	—	—	—	—	0	0
Areolated fruits	11	—	—	—	—	—	6	54.55
Frs. with undeveloped calyx lobes	11	—	—	—	—	—	1	9.09
Frs. with long narrow calyx lobes	11	—	—	—	—	—	0	0
Fruits containing seeds	11	—	—	—	—	—	0	0
Apical depression	11	11 100.00	0 0	0 0	0 0%	—	—	—
Apical dots	11	8 72.73	3 27.27	0 0%	—	—	—	—
Flatness of fruit	11	11 100.00	0 0	0 0	0 0	0 0%	—	—
Smoothness of fruit	11	6 54.55	2 18.18	2 18.18	1 9.09	0 0%	—	—
Thinness of rind	11	7 63.64	2 18.18	0 0	1 9.09	1 9.09%	—	—
Thinness of segment wall	11	9 81.82	2 18.18	0 0	0 0	0 0%	—	—
Color of pulp	11	4 36.36	2 18.18	5 45.45	0 0	0 0%	—	—
Size of central column	11	4 36.36	7 63.64	0 0	0 0	0 0%	—	—
Quantity of pith	11	1 9.09	9 81.82	1 9.09	0 0	0 0%	—	—
Quality of pulp	11	0 0	1 9.09	2 18.18	6 54.55	2 18.18%	—	—



The measurements of these fruits are given in Table 210.\*

The fruits of the same branch were re-examined in 1924. The following note was taken in examining the entire crop :

Fruits extremely flat, with very broadly flat-concave stem-end, which lacks oil cell dots to a certain extent. Fine striations radiate from this flat, naked area. Calyx normal, rather irregularly astellate. Outline of the fruit is uniformly round. Apex very broadly flat-concave, with remarkably large dot-less area. Areola exist, but not strongly pitted. Surface of fruit typically smooth, sometimes pitted rather sharply (in green fruits). Dots conspicuously large and distant. Color deep, rarely green. Surface grooved along the suture line of each segment.

Cross-section : Rind thin, segment wall thin, pulp deep-colored, vesicles finely anastomosing, and central column large. In late-bloom fruits, rind thick, wall moderately thin, central column large, with abundant pith, pulp light-colored, vesiculation more or less parallel. Oil cells in normal and late-bloom fruits are large, often very large, quite distinct, especially in the latter kind of fruits. Taste of both is inferior, insipid to acid, deteriorating very rapidly.

The measurements of these fruits are given in Table 211.\*\*

Judging from these investigations, Yamamoto HIRAMI Satsuma cannot be ranked in the same group as Wase Satsuma, although it is slightly earlier than the common Owari. It is a kind of worthless bud mutation, not deserving any economic consideration.

### NORMAL PART OF THE YAMAMOTO HIRAMI SATSUMA

In 1923, 18 fruits from a branch of the normal part of YAMAMOTO's bud variation tree were received from Mr. TOGASHI. The description of these fruits is given as follows :

Fruits rather large in size, equi-dorsiventral and flat. Apex broadly

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\* PL. XLVI, Fig. 4.

\*\* PL. XLVI, Fig. 5.

TABLE 212.

MEASUREMENT OF 18 FRUITS (NOS. 7213-7230) FROM NORMAL PART OF  
YAMAMOTO'S BUD VARIATION TREE AT HAYAKAWA,  
KANAGAWA PREFECTURE. LOT NO. 99 OF 1923.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
10.00 cm.	4.12 cm.	1.39	71.67 gm.	8.72 mm.	9.80	2.36 mm.	11.86 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	18	—	—	—	—	—	2	% 11.11
Sinuate based fruits	18	—	—	—	—	—	0	0
Semi-sinuate based fruits	18	—	—	—	—	—	1	5.56
Arcolated fruits	18	—	—	—	—	—	8	44.44
Frs. with undeveloped calyx lobes	18	—	—	—	—	—	9	50.00
Frs. with long narrow calyx lobes	18	—	—	—	—	—	0	0
Fruits containing seeds	18	—	—	—	—	—	0	0
Apical depression	18	<sup>2</sup> 11.11	<sup>9</sup> 50.00	<sup>7</sup> 38.89	<sup>0</sup> 0%	—	—	—
Apical dots	18	<sup>2</sup> 11.11	<sup>10</sup> 55.56	<sup>6</sup> 33.33%	—	—	—	—
Flatness of fruit	18	<sup>13</sup> 72.22	<sup>5</sup> 27.78	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Smoothness of fruit	18	<sup>2</sup> 11.11	<sup>10</sup> 55.56	<sup>6</sup> 33.33	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Thinness of rind	18	<sup>14</sup> 77.78	<sup>4</sup> 22.22	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Thinness of segment wall	18	<sup>17</sup> 94.44	<sup>1</sup> 5.56	<sup>0</sup> 0	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Color of pulp	18	<sup>11</sup> 61.11	<sup>5</sup> 27.78	<sup>2</sup> 11.11	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Size of central column	18	<sup>0</sup> 0	<sup>4</sup> 22.22	<sup>10</sup> 55.56	<sup>3</sup> 16.67	<sup>1</sup> 5.56%	—	—
Quantity of pith	18	<sup>0</sup> 0	<sup>2</sup> 11.11	<sup>16</sup> 88.89	<sup>0</sup> 0	<sup>0</sup> 0%	—	—
Quality of pulp	18	<sup>0</sup> 0	<sup>4</sup> 22.22	<sup>6</sup> 33.33	<sup>6</sup> 33.33	<sup>2</sup> 11.11%	—	—

shallow-concave, with normal oil cell arrangement, a few fruits having a naked apex. Areola occasionally present, but navel rarely open. Base generally deep-concave, rarely being sinuous. Calyx lobes very frequently undeveloped, surrounding area being crater-like, sometimes leaving naked area, as in the variation fruits, though less in extent. Surface rather even, oil cell dots normal, well-colored, tight-skinned, and fully matured on Nov. 22, 1923.

Cross-section: Rind normally thin, wall also thin, central column medium in size with more or less abundant pith. Pulp deep-colored, of ordinary quality, tasting still acidulous. Vesiculation rather coarse.

It is an ordinary Owari of no particular merit. The measurements of the fruits are given in Table 212.\*

### TSUDA'S HIRAMI SATSUMA, POSSIBLY OF BUD VARIATION ORIGIN

In November, 1924, the writer was taken by Mr. TOGASHI of the Kanagawa Agricultural Experiment Station, to a plant which was yielding flat Satsuma fruits resembling those of YAMAMOTO's Hirami Satsuma. The tree is owned by Naminosuke TSUDA of Yuzaka, Kawamuragishi, Kawa-mura, Ashigarashimo-gun, Kanagawa-ken (PL. LIII, Fig. 12 and 12\*). This is a tree originally taking two kinds of buds. The upright main trunk bears flat fruits, and two lower branches coming out from the bottom of the former bear normal fruits. The whole plant is 3.2 m. high, having a spread in the N-S direction of 3.8 m., and in the N-W direction of 3.5 m. The distance from other trees is about 4.4 m. The major part, bearing flat fruits, is tall, upright, branching first at 69 cm. from the ground. Branches many, dense, bearing upright, short, slow-growing branchlets. Leaves small, hanging or horizontal, not upright. Shape of leaves normal, narrow, with a conspicuously curled appearance, color normal. The normal part of the tree is more vigorous looking, with stronger, straight shoots and many crowded leaves. The tree was planted

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\* PL. XLVII, Fig. 1.

in 1898 by a man from Okitsu to whom the owner used to sell fruits. About 100 trees were planted at the same time, and this particular tree became known as abnormal quite a long time ago. The color comes about Oct. 10th, and the fruit is usually picked off by boys before coming to full maturity. The soil condition is fairly good, surface soil about 30 cm. deep, bottom soil is Fuji volcanic silt. Fertilization per tree consists of 4-5 sho (7.3-9.1 litres) of rape seed cake, and 1 shô (1.8 litre) of superphosphate of lime.

Two fruits (Nos. 8149-8150) were first received from Mr. TOGASHI, the description of which is given below :

Fruits extremely flat without naked area around the calyx. Surface even but slightly pitted, especially at the base and in the areola region. Stem-end shallowly broad-concave. Calyx normal without enlarged disk. Apex much flattened, broadly but shallowly concave with very pronounced areola. Navel closed. Color almost light cadmium (RIDGEWAY, P. IV.), and shiny.

Cross-section : Rind thin, segment wall thin, central column medium-sized with medium amount of pith. Pulp medium-deep in color, juicy, soft, quality medium-good having a sufficient amount of sugar. Vesiculation fine, not like Wase, many vesicles becoming free at the inner part of the segment due possibly to its abrupt expansion.

Four fruits (Nos. 9810-9813) were found left unpicked on the tree when it was visited by the writer. These were a late pick of smaller fruits, the description of which is given below :

Fruits small, flat, deep-colored, smooth, some are finely pitted (No. 9811). Oil cells fine, uniform, close, even (concave in No. 9811). Apex broadly-concave, areolate, dots reaching to the stylar point. Navel generally open. Base normal, concave, some grooved sharply (No. 9811), some rather flattened (No. 9813). Calyx normal, small, disk concealed. The general appearance is not like Wase. Shape is very flat, but not like the former lot picked earlier. This is unquestionably a variation within the Owari variety, and not a new Wase caused through bud variation.

Cross-section : Rind thin, wall thin, central column rather large and amount of pith slightly abundant. Pulp typically deep-colored and of

TABLE 213.

MEASUREMENT OF 6 FRUITS (NOS. 8149, 8150, 9810-9813) OF TSUDA'S HIRAMI  
SATSUMA AT KAWAMURA, KANAGAWA PREFECTURE.  
LOT NO. 118 AND 152 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
18.40 cm.	3.57 cm.	1.64	69.33 gm.	9.80 mm.	10.67	2.25 mm.	12.83 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	6	—	—	—	—	—	3	50.00
Sinuate based fruits	6	—	—	—	—	—	1	16.67
Semi-sinuate based fruits	6	—	—	—	—	—	0	0
Areolated fruits	6	—	—	—	—	—	5	83.33
Frs. with undeveloped calyx lobes	6	—	—	—	—	—	0	0
Frs. with long narrow calyx lobes	6	—	—	—	—	—	0	0
Fruits containing seeds	6	—	—	—	—	—	0	0
Apical depression	6	1 16.67	5 83.33	0 0	0 0%	—	—	—
Apical dots	6	0 0	1 16.67	5 83.33%	—	—	—	—
Flatness of fruit	6	6 100.00	0 0	0 0	0 0	0 0%	—	—
Smoothness of fruit	6	2 33.33	4 66.67	0 0	0 0	0 0%	—	—
Thinness of rind	6	6 100.00	0 0	0 0	0 0	0 0%	—	—
Thinness of segment wall	6	4 66.67	2 33.33	0 0	0 0	0 0%	—	—
Color of pulp	6	2 33.33	4 66.67	0 0	0 0	0 0%	—	—
Size of central column	6	0 0	2 33.33	4 66.67	0 0	0 0%	—	—
Quantity of pith	6	0 0	0 0	6 100.00	0 0	0 0%	—	—
Quality of pulp	5	1 20.00	4 80.00	0 0	0 0	0 0%	—	—

good quality, flavor intense, not dilute as in Wase. Oil cells of the rind rather small and continuous. Vesiculation fine.

Measurements of these six fruits altogether are given in Table 213.\*

### NORMAL FRUITS ON BRANCHES OTHER THAN THOSE BEARING HIRAMI CROP

The lower branch, originally grafted with a normal bud, bears flat fruits typical of the Owari variety. Twenty-five fruits were collected when the tree was visited and they were studied on Jan. 14, 1925. The description is given below :

Fruits small, flat, beautifully smooth, deep-colored, with small, equally distributed flat or convex oil cell dots, and the surface is almost not pitted at all. Apex broadly shallow-concave, areola occasionally present, not prominent, navel closed or open. Base flattened or slightly depressed, never sinuous. Calyx normal, with a disk entirely covered.

Cross-section : Rind thin, wall also uniformly thin, central column medium to small with rather little pith. Pulp deep-colored, juicy, fine-grained, more or less acidulous, not sweet enough, probably slightly over-ripe.

The measurements of fruits are given in Table 214.\*\*

This table shows that the fruit is slightly taller than the fruits of Tsuda Hirami Satsuma, but the other characters are nearly similar being without any appreciable difference.

No evidence is available to prove that Tsuda Hirami Satsuma was originated through a bud variation, but apparently it was unconsciously propagated from a certain branch which had shown such variation, since the flat form here described is not seen in cultivation anywhere. Although this is not a case of Wase variation, it is of botanical interest that such a form is possible.

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\* PL. XLVII, Fig. 2 and 3.

\*\* PL. XLVII, Fig. 4.

TABLE 214.

MEASUREMENT OF 25 OWARI FRUITS (NOS. 9835-9853) FROM TSUDA'S HIRAMI SATSUMA TREE AT KAWAMURA, KANAGAWA PREFECTURE.  
LOT NO. 154 OF 1924.

Av. Girth	Av. Height	D/H Index	Av. Weight	Calyx	No. Segm'ts.	Rind	Center
16.43 cm.	3.48 cm.	1.53	53.96 gm.	9.58 mm.	10.56	1.83 mm.	9.92 mm.

No. of fruits examined		Class					Total	
		1	2	3	4	5		
Naveled fruits	25	—	—	—	—	—	8	32.00
Sinuate based fruits	25	—	—	—	—	—	3	12.00
Semi-sinuate based fruits	25	—	—	—	—	—	0	0
Areolated fruits	25	—	—	—	—	—	12	48.00
Frs. with undeveloped calyx lobes	25	—	—	—	—	—	1	4.00
Frs. with long narrow calyx lobes	25	—	—	—	—	—	0	0
Fruits containing seeds	25	—	—	—	—	—	0	0
Apical depression	25	1 4.00	17 68.00	7 28.00	0 0%	—	—	—
Apical dots	25	2 8.00	18 72.00	5 20.00%	—	—	—	—
Flatness of fruit	25	22 88.00	3 12.00	0 0	0 0	0 0%	—	—
Smoothness of fruit	25	10 40.00	14 56.00	1 4.00	0 0	0 0%	—	—
Thinness of rind	25	24 96.00	1 4.00	0 0	0 0	0 0%	—	—
Thinness of segment wall	25	25 100.00	0 0	0 0	0 0	0 0%	—	—
Color of pulp	25	23 92.00	2 8.00	0 0	0 0	0 0%	—	—
Size of central column	25	0 0	1 4.00	11 44.00	12 48.00	1 4.00%	—	—
Quantity of pith	25	0 0	1 4.00	18 72.00	6 24.00	0 0%	—	—
Quality of pulp	25	3 12.00	9 36.00	12 48.00	1 4.00	0 0%	—	—

## FURTHER DISCOVERIES OF BUD VARIATION WASE SATSUMAS

On the occasion of the author's leave to go abroad, the continuation of the Wase Satsuma work was entrusted to Mr. Miyawo NAKAMURA of Kyushu Imperial University, who was able to locate one new strain of the Wase Satsuma in Shidzuoka Prefecture.<sup>(80)</sup>

This not a case in which the original bud mutant is in existence, but is such variation as was propagated unconsciously, as in the case of Yakushiji Wase, Kawano Wase, and Sueoka Wase. The plant is located in the orchard owned by Bunkichi KATAHIRA, at Sannomae, Kashio, Takabe-mura, Shidzuoka-ken, being the second tree in the uppermost plot after passing the third turn on the path leading from the back of the owner's house. The plant was propagated in about 1902 from a Satsuma plant purchased from Wakayama Prefecture in 1878. The diameter of the tree is 2.2 m. in its E-W spread, 3.1 m. in N-S spread, and the height is 1.9 m. The branches are rather bushy and the tree looks somewhat dwarfed; leaves are abnormal due to defoliation in a severe winter, and look yellowish; they are pointed at the apex, but are not twisted. The fruit is rather small in size, oblate or oblate-conical, apex flattened, areolate, navel often present. Base somewhat crater-like, with fine striations; calyx large, rather irregular in shape, lobes well developed. Surface smooth, deep-colored, oil cell dots large, dense, generally concave, occasionally convex.

Cross-section: Rind thin, wall medium-thin, central column rather small, less amount of pith. Segments 8-12, pulp juicy, of good taste. Pulp vesicles large, coarsely netted. Fruit starts coloring about the end of September; the first pick is completed about the middle of October, and the last pick at the end of October. Many third generation trees are planted in the orchard belonging to Sôhei KATAHIRA, which are all true to type and are famous as the Wase of Mukaiyama Hill. Mr. NAKAMURA remarks that the variation in the size of fruit is great and the average size is too small for any commercial planting. Although he does not mention its relation to Kawano Wase, it is impossible to imagine



that the latter was introduced into Wakayama Prefecture fifty years ago and brought to Shidzuoka Prefecture, giving rise to this strain. He is perhaps right in maintaining that the original bud variation took place in Wakayama Prefecture, and came here by unconscious multiplication. Judging from the general character described, this looks to be a relative of the Ueno Wase of Wakayama Prefecture, which was originated from the Ikeda variety.

### NORO'S CONTINUATION OF THE SATSUMA BUD VARIATION WORK

When the author and Dr. SWINGLE were actively at work in Shidzuoka Prefecture, the Department of Agriculture of the prefecture sent Mr. Tsunatarô FUJIWARA, chief agriculturist, to assist in the work. He was thoroughly convinced of the importance of the work then under the way in cooperation with the local agent of Mikkabi and he promised to organize a force of research workers to continue and extend the work already carried out by the author. As the result of his efficient management, the prefecture inaugurated a plan to review the author's work already accomplished and to go forward to locate new bud variations, making a thorough comparison of each strain of bud mutant by propagating it and growing it in an orchard. Mr. Kimijirô NORO was employed to carry out this project and by his splendid activity made progress in finding some additional mutants.

In August, 1928, he issued his first preliminary report<sup>(*Ann.*)</sup>, in which 39 strains (33 from Shidzuoka Prefecture, and 6 from other prefectures) are briefly described with some illustrations and photographs. This list includes comparatively few Wase mutants, a large number being a series of rather undesirable variations, very frequently existing and entirely left out by the writer of the present paper as being of no use. It includes three cases of willow leaf mutations, a common mutation already reported by the writer, one Hiramî Owari, four strains of straight Owari, one Kawano Wase, one questionable Ikeda, and another questionable so-called unproductive individual. The largest number of variations is recorded from Mikkabi—the result of the education given to Mr. MATSUI and others by the

TABLE 215.

A LIST OF SUPPOSED BUD VARIATIONS AND INDIVIDUALS MENTIONED IN  
NORO'S FIRST PRELIMINARY REPORT ON BUD VARIANTS PUBLISHED  
BY THE SHIDZUOKA AGRICULTURAL EXP. STAT., 1923.

Noro's Number	Locality	Owner of plant	Discoverer	Determination of		
				Discoverer	Noro	Writer
Mikkabi 1.	Akazari	YAMAGUCHI, Zenpachi	SUZUKI, Epei	—	Wase $\Delta$	?
Mikkabi 2.	Kamiona	ONO, Gizô	NATSUME, Shôtarô	—	Wase	Wase ?
Mikkabi 3.	do.	do.	house people & MATSUI, Ken'itsu	Wase	Wase $\Delta$	Wase ?
Mikkabi 4.	Hirayama	MORITA, Ritarô	owner ?	—	Wase	?
Mikkabi 5.	do.	do.	—	—	Wase $\Delta$	?
Mikkabi 6.	do.	do.	owner ?	Wase	Wase $\Delta$	Wase ?
Mikkabi 7.	Nagane	SHIMIDZU, Zenpachi	—	—	Wase	?
Mikkabi 8.	Okuhirayama	Young Mens' Ass'n	—	—	Wase	?
Mikkabi 9.	do.	YAMAGUCHI, Takichi	—	—	Willow	Willow
Mikkabi 10.	Hirayama	KATÔ, Yasuhei	owner ?	Wase	Wase	Wase ?
Mikkabi 11.	Okamoto	TOYAMA, Kosaka	owner ?	Wase	Wase	?
Higashima- shisu 1.	Ohama	KITAGAWA, Shichizô	—	—	Wase	?
Higashima- shisu 2.	Nakasato	MATSUHIRA, Sôtarô	SHIMMURA	Wase	Wase $\Delta$	??
Okabe 1.	Miwa	ÔNATA, Rokuhei	NAKAYAMA	—	Wase $\Delta$	??
Asahata 1.	Arinaga	SATÔ, Yûhei	owner	Wase ?	Wase $\Delta$	Wase
Asahata 2.	Hinami	SUGIYAMA, Ichijin	owner	—	Wase	?
Asahata 3.	do.	SUGIYAMA, Kinsaku	owner	Wase	Wase $\Delta$	?
Asahata 4.	do.	do.	owner ?	Wase	Wase $\Delta$	?

TABLE 215.—(Continued)

Noro's Number	Locality	Owner of plant	Discoverer	Determination of		
				Discoverer	Noro	Writer
Asahata 5.	do.	SUGIURA, Ichirô	owner ?	Wase	Wase $\Delta$	Wase ?
Asahata 6.	do.	Britô, Ginnosuke	—	(Individual tree)		Kawano Wase
Asahata 7.	do.	SATÔ, Hanzaemon	owner	Willow	Willow	Willow
Asahata 8.	do.	do.	owner	Willow	Willow	Willow
Asahata 9.	do.	do.	owner	—	Midseason $\Delta$	??
Asahata 10.	Arinaga	SATÔ, Raizô	— *	—	Late	Ikeda
Takabe 1.	Torisaka	MOCHIDZUKI, Shôaku	YOSHIDA, Kashichi	Wase	Wase $\Delta$	?
Takabe 2	Torisaka	Taifukuji temple	a monk	(Individual tree)	Wase $\Delta$	??
Iwara 1.	Hara	MOCHIDZUKI, Yoshiyuki	owner	—	Variigated $\Delta$	??
Iwara 2.	do.	MOCHIDZUKI, Kôaku	MOCHIDZUKI, Yoshiyuki	(Individual tree)	Unproductive	??
Iwara 3.	Sugiyama	KATAHIRA, Minesaburô	MAKITA, Taishi	Wase	Flat $\Delta$	Wase
Iwamatsu 1.	Matsuoka	TASUGI Takejirô	Fuji Agr. Soc.	—	Wase $\Delta$	?
Okuyama 1.	Okuyama	MIYAZAKI, Hyakuho	owner	—	Dry	Wase ?
Osada 1.	Ôwada	WADA, Naokichi	owner	Wase	Wase	Wase
Osada 2.	—	ISHIGAMI, Kyûtarô	—	(Individual tree, Seedling*)	—	Owari
Kanagawa 1.	Kamigun, Kawamura, Mukaizaka	UCHIDA, Kamekichi	KOIDZUMI, Takurô	Wase	$\pm$ late $\Delta$	Owari
Tsuda Wase	do.	TSUDA, Naminosuke	TANAKA, Tyôsaburô (unpublished)	—	Wase	Hirami Satsuma
Mie 1.	Takigun, Sanamura Kôzaka	URATA, Koemon	—***	—	Wase	Owari
Osaka 1.	Senhokugun, Yokoyamamura, Fukuse	NAKARAYASHI, Kwanji	ODA, Kihachi	—	Hira Wase	Hirami Satsuma

TABLE 215.—(Continued)

Noro's Number	Locality	Owner of plant	Discoverer	Determination of		
				Discoverer	Noro	Writer
Hiroshima 1.	Toyodagun, Hisatomomura, Kubi	SHINTANI, Toshio	KOBAYASHI, etc.	—	Wase <sup>△</sup>	???
Hiroshima 2.	do.	ORIGUCHI, Fudematsu	do.	—	Wase <sup>△</sup>	???
Hiroshima 3.	do.	MICHIMOTO, Kenzô	do.	—	Wase <sup>△</sup>	???

\* NORO says "TANAKA gives the name *Sato Raizo Wase* and counts this a Wase strain", but this is wrong as the author only stated, "In a talk with Mr. TAKAHASHI, the writer was informed that there are *Sato Raizo Wase* and *Miho Wase* which Mr. TAKAHASHI said that he has not studied fully as yet."

\*\* NORO states that the writer published this name in *Studia Citologica* Vol. 1 No. 1, but this is a mistake, since it was never published, though the study was made by the writer.

\*\*\*This Sour-scab resistant strain of the Owari Satsuma was first studied by the writer and Dr. SWINGLE in October, 1926. NORO, obviously knowing that the original study was made by us, published this strain without any mention of it.

△ First named recently by NORO (87b).

author— Asahata coming next. The list, with the author's identification judged from Mr. NORO's description, is given in Table, 215.

The second preliminary report was published in July, 1929<sup>(86)</sup>, giving 26 numbers (17 from Shidzuoka Prefecture, and 9 from other prefectures). The list of names, with the author's interpretation, is given in Table, 216.

A paper giving further reports and some revision of former views was published lately<sup>(87b)</sup>. Table 217 gives an outlook of new strains first reported in this paper.

TABLE 216.

A LIST OF SUPPOSED BUD VARIATIONS AND INDIVIDUALS MENTIONED IN  
NORO'S SECOND PRELIMINARY REPORT ON BUD VARIANTS  
PUBLISHED BY THE SHIDZUOKA AGRICULTURAL  
EXP. STAT., 1929.

Noro's Number	Locality	Owner of plant	Discoverer (reporter)	Determination of		
				Discoverer (reporter)	Noro	Writer
Mikkabi 12.	Hirayama	KATÔ, Yasuhei	—	—	Wase $\Delta$	?
Mikkabi 13.	do.	do.	house people	—	Small fr.	?
Mikkabi 14.	Nueshiro	NATSUME, Kakuhei	—	—	Wase $\Delta$	?
Mikkabi 15.	Shimoono	TOYAMA, Koichi	owner ?	—	Wase $\Delta$	Wase ?
Mikkabi 16.	Daifukji	FUJIYAMA, Ryûichi	ISHIBASHI, Shigeo	—	Mamillate	Owari
Wada 1.	Ishiki	RYÔCHI, Misao	owner	—	Corrugated	Owari ?
Osada 3.	Ôwada	MASUDA, Shigeru	do.	—	do.	Owari ?
Asahata 11.	Minami	YAMAOKA, Bunjirô	BITO, Ginnosuke	—	Late ? $\Delta$	?
Iwara 4.	Hirose	SUGIYAMA, Kenkichi	YOSHIDA, Kashichi	—	Wase ?	Wase ?
Iwara 5.	Yamakiri	UMEDA, Kikujirô	YOSHIDA, Kashichi	—	Wase	Wase ?
Iwara 6.	Sugiyama	AOKI, Kikunosuke	Sugiyama Ass'n	—	Wase	Wase ?
Shimidzu 1.	Muramatsu	ÔTAKI, Tokijirô	MIDZUNO, Shin	Wase	Wase	Wase ?
Sodeshi 1.	Yokozuna	ICHIKAWA, Torazô	NAKAGAWA, Sôtarô Wase	Wase	Yellow*	Owari variegated
Kambara 1.	Kamizawa	ISHIKAWA, Ichitarô	do. & ICHIKAWA	—	Variegated	do.
Kambara 2.	Shinden	YAMAMOTO, Matsujirô	owner ?	—	Wase	?
Kambara 3.	do.	do.	house people	—	Hira Wase	Hirami Satsuma
Iwamatsu 2.	Kashima-mura	YOSHIZAWA, Kenzô	individual with reverted shoot ?	—	Kawano Wase	?
Hiroshima 4.	Toyoda-gun, Hisatomo-mura, Kubi	DEGUCHI, Kashichi	SHINTANI, Kayoshi & DEGUCHI, Asaichi	—	Wase $\Delta$	?

TABLE 216.—(Continued)

Noro's Number	Locality	Owner of plant	Discoverer (reporter)	Determination of		
				Discoverer (reporter)	NORO	Writer
Hiroshima 5.	do.	DEGUCHI, Asaichi	owner ?	Wase	? (Wase $\Delta$ )	?
Hiroshima 6.	Mitsugi-gun, Sannoshô-machi, Minami	OKA, Kumaichi	YUKIZAKI, Yôjiro & HÔMAN, reporter found by owner	Wase	Wase $\Delta$	Wase
Osaka 2.	Sennan-gun, Yamataekami-mura, Yama-taenaka	KUROISHI, Yometarô	owner	(Individual tree)	Wase $\Delta$	Wase ?
Osaka 3.	Minamikawachi-gun, Tôjômura, Byûsen	UEJÔ, Yoichirô	—	—	Wase $\Delta$	Ikeda?
Wakayama 1.	Kaisô-gun, Hamanaka-mura	KAWAMURA, Sôtarô	IWASAKI, Yoshio	—	Wase**	?
Wakayama 2	Arita-gun, Miya bara-mura, Michi	NARIKAWA, Sôsuke	do.	—	Wase $\Delta$	Owari
Wakayama 3	do.	do.	do.	—	Willow	Willow
Wakayama 4.	Aritagun, Tasu-kawa-mura, Tanura	DATE, Sadakichi	do.	(Individual trees)	Midsea-son $\Delta$	Owari

SUPPLEMENTARY REPORT OF THE FIRST PRELIMINARY REPORT,  
SHOWN IN TABLE 215.

Mikkabi 4.	—	—	—	—	Wase $\Delta$	Wase ?
Mikkabi 10.	—	—	—	—	Wase $\Delta$	?
Higashimashidzu 2.	—	—	—	—	Wase $\Delta$	?
Asahata 10.	—	—	—	—	Uncertain $\Delta$	Ikeda
Hiroshima 1.	—	—	—	—	Wase $\Delta$	?
Hiroshima 2.	—	—	—	—	Wase $\Delta$	?
Hiroshima 3.	—	—	—	Wase	? Wase $\Delta$	?

\* This is not the "Yellow" in SHAMEL'S sense, thought NORO took it to be. Unquestionably, this is a true variegated mutant, but the true Yellow strain of the Washington Navel orange has a normal leaf.

\*\* This may be identical with NARIKAWA'S so-called large-fruited individual reported by the writer here in this paper. In that case, it is not a Wase.

$\Delta$  According to NORO'S recent revision<sup>(87b)</sup>.

TABLE 217.

A SUPPLEMENTARY LIST OF SUPPOSED BUD VARIATION FOUND  
BY NORO SINCE 1930.

Noro's Number	Locality	Owner of plant	Discoverer	Determination of		
				Disco- verer	Noro	Writer
Mikkabi 17.	Daifukuji	ISHIBASHI, Shigeo	—	—	Lozenge- leaf	?
Osada 4.	Kosaka	SHIOZAWA, Heiji	ÔSAWA, Kiyoshi	—	Yamabuki	—*
Osada 5.	Kosaka	ÔSAWA, Kiyoshi	—	—	Flat	Flat
Shidzuoka 1.	Kawaraba	KAWAE, Hideo	—	—	Wase	—
Asahata 12.	Arinaga	FURUYA, Saburô	—	—	Lozenge- leaf	?
Iwara 7.	Iwara	OGASAWARA, Sôichirô	—	—	Tomato	—**
Wakayama 5.	Arita-gun, Minoshima-chô	EGAWA, Sen'emon	—	—	Rosy	—***
Kanagawa 2.	Ashigarashima- gun, Kataura- mura, Ishibashi	TUJIMURA, Gonjirô	WARASHINA, Masao	—	Large-leaf	?
Kagawa 1.	Ayauta-gun, Takinomiya- mura	TAKASHIGE, Masaji	—	—	Willow	Willow

\* Light-colored type like this has been reported by SHAMEL and others<sup>(110)(113)</sup> in Washington Navel orange.

\*\* Fruits with decreased number of oil cell dots on their smooth surface and with increased amount of pith in the central column. This sounds like fruits borne on tetraploil individuals of the other Citrus fruits.

\*\*\*Fruit with very intense color of rind.

Noro<sup>1)</sup>, in a recent publication, described a still newer limb variation of the Satsuma orange, called "Hiraoka-kei", found at Kosaka, Osada-mura, Abe-gun, Shidzuoka-ken. This is a sport with fruit having very smooth rind and greatly reduced number and size of the oil cells. He described more in detail those monstrosities already named "Tomato", "Rosy" and "Lozenge-leaved".

1) NORO, Kimijirô. Unshû Mikan no nisan Keitô ni tsukite (On a few strains of the Satsuma orange). in Nôgyô oyobi Engei (Agr. & Hort.) 6 (6): 925-932, illus., S. 6 (1931).

*Subsequent discoveries*

After the completion of the present paper, the author received some more additional information on the occurrence of new strains of the Wase Satsuma of definitely bud-variation origin. In a pamphlet<sup>1)</sup> and a magazine article<sup>2)</sup> Mr. Sukesaburô IZEKI of Ryûmon in Wakayama-Ken, made an announcement of the superiority of the Izeki Wase found by him in his orchard as a result of extensive investigations carried out by the encouragement of Dr. SWINGLE and the author. A fruit of Izeki Wase received in 1931 showed a good quality, but its particular desirability was not proved. He also made a series of experiments of Wase strains on the rootstocks, sent by Dr. SWINGLE, but no conclusion with reliable data, has been reached.

Mr. ODA and YAMAOKA<sup>3)</sup> also published an account of the discovery of the Kamei Wase, found by Seichirô KAMEI, in the orchard of Rihei I-HIGURO at Yamataenaka, Yamataekami-mura, Sennan-gun, Ôsaka-fu. A fruit (No. 11103) sent by the junior author to the writer proved to be a good Wase of normal size and pulp quality. Several other new strains of the Wase Satsuma were discovered by the same person, and subsequently named by him "Okutani Wase" "Okutani No. 2 Wase" "Tanaka Wase" "Sawa No. 2 Wase". The validity of the Wase characters was proved by the writer through the actual investigation of fruit samples sent by him through the Tanaka Citrus Experiment Station. A detailed report by the writer about these new Wase strains reported by these three authors will be published elsewhere.

TAKAHASHI<sup>4)</sup> published sketches of other new strains of Wase Satsuma without descriptions. Unquestionably he has made successive discoveries of new strains, but the publication of the data has not yet been attempted. Names of these new Wase Satsumas are "Watanabe Wase" and "Ogashira Wase", the latter being a select clone of the Kawano Wase and not a new bud variant, according to his short remarks.

- 1) IZEKI, Sukesaburô. Wase Unshû Mikan no Keiciron (A discourse on orchard management of the Wase Satsuma). Wakayama-ken, author, S. 6 (1931).
- 2) ——— Wase Unahû no Shurui Kairyô ni tsukite (On the improvement of the strains of the Wase Satsuma). in Nippon Mikan Shimpô (Jap. Citrus Courier). No. 37, p. 5; no. 38, p. 5; no. 39, p. 5. illus., S. 6 (1931).
- 3) ODA, Onihachi & YAMAOKA, Teruhei. Wase Unshû no Shinshu Kamei Wase ni tsukite (On Kamei Wase, a new strain of the Wase Satsuma). in Nôgyô oyobi Engei (Agr. & Hort.) 7 (1): 147-150, illus., S. 7 (1932).
- 4) TAKAHASHI, Ikurô. Unshû Mikan no Kenkyû (Studies in the Satsuma orange). in Zissai Engei (Pract. Hort.) 12 (1): 37-43, illus., S. 7 (1932).



## THE INTERPRETATION OF THE WASE BUD VARIATION IN THE SATSUMA ORANGE

From our present knowledge, the case of Wase bud variation is a phenomenon most difficult to explain. It is an "ever sporting" type of variation, which occurs in all varieties of the Satsuma orange, and the sport is susceptible to reciprocal vegetative reversion, as shown by its very frequent occurrence in Kawano Wase.

As to the explanation of the fact, the author<sup>(170)</sup> first wrote the following passages :

"Many instances of bud variation have been reported in horticultural literature, especially with Citrus fruits, through the recent investigations of SHAMEI\* and his co-workers. SHAMEI also has described a bud variation (analogous to the Wase Satsuma) in the French prune, giving rise to a large-fruited type from which occasional reverting branches are produced. As closer studies of such bud sports are made, this phenomenon of reversion may be found not infrequent, though but few cases are recorded at present. CORRENS made a thorough study of variegation in *Mirabilis*, in which he found both bud variation and vegetative reversion very common. STOUT, in propagating green-leaved bud sports of *Coleus* arising from yellow-leaved plants, found the yellow pattern reappearing in a certain number of plants, an occurrence which he called reversion. WETTSTEIN reported the occurrence through bud variation of a fasciated branch upon a normal plant of *Sedum reflexum*. Its seed-propagated progeny showed a tendency to reversion to the normal form, though no vegetative reversion was seen. REINKE reported a striking case of bud variation of a red-flowered individual of *Phaseolus multiflorus*, a branch of which showed no existence of anthocyanin pigment. The new character did not stay constant through seed propagation, but always segregated the original character in the ratio apparently corresponding to a Mendelian recessive. BLAKESLEE recently found that vegetative reversion occurs in the seed progenies of the dwarf mutant of *Portulaca grandiflora*. He found only a single case of original mutation among thousands of normal plants, but the individuals with reverting branches constituted 1.23 percent of the progeny of the mutant. His genetic study confirms the belief that the dwarf character is clearly recessive to normal, and the reverted normal is heterozygous with respect to dwarfness. No explanation as to regaining heterozygosity from a homozygous dwarf is presented, though he believes that the original mutation might have occurred on a heterozygous normal plant. Likewise, bud variation is often considered as occurring more frequently in the case of heterozygous plants than with the homozygous individual, as pointed out by EAST, but we still have evidence that it may arise in pure-line individuals, as JOHANSEN discovered in *Phaseolus vulgaris*.

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\* The number of literature quoted is omitted. See Bibliography.

"There are several explanations as to the process of bud variation. EAST first presented the idea that bud variation is the same as germinal mutation, the only difference being that it happens in a somatic cell. EMERSON'S experiments with variegated ears of Maize presented some proof of this possibility. BATESON, on the other hand, introduced the conception of somatic segregation of a Mendelian recessive, and later experiments of EAST appear to be in favor of this hypothesis. STOUT suggested, however, the possibility that some cases of bud variation occur in the form of periclinal chimeras. Later he discovered an apple tree with two kinds of branches, which he attributed to chimeric origin. After WINKLER'S epoch-making discovery of plant chimeras, many phenomena of unknown origin were attributed to chimeras, with insufficient justification, but the existence and importance of the chimera in practical breeding remains beyond doubt, as is illustrated in WINKLER'S final paper, summarizing all his previous investigations.

"The first explanation (a change occurring in a somatic cell) seems well adapted to explain the appearance of a simple recessive character through bud variation, but in a case like that of the Wase Satsuma orange the characters are much too complicated to be explained by a simple loss of dominancy by mutation. From every viewpoint, the fruit of the Wase Satsuma orange represents a progressive, not a degressive, change, and the Wase characters are apparently complex. Does this represent a case of progressive somatic mutation? Is the factor complex so closely linked as to bring about a simultaneous change, or does the mutation of a different factor occur simultaneously? If it be a case of somatic segregation, what basis is there for regarding Owari variety as a hybrid?\* Or is the origination of the Wase variety simply the reappearance of a long-lost ancestral character, as instanced by DARWIN?

"If, however, the Wase variety should be a periclinal chimera, what sort of progeny should we obtain from a pure Wase branch, such as is often found on chimeric plants through vegetative segregation, as shown by DE VRIES in the case of *Cytisus adami* or by WINKLER in *Solanum tubingense* and *S. proteus*?

"To solve these and related problems would require no little time and work, but the result of such an investigations will be of vital interest to breeders, pomologists, and orchardists."

Three years after the publication of the text above given, the author<sup>(172)</sup> proposed a second assumption, which reads as follows:

"In the writer's report, questions were raised whether the origination of Wase characters first is due to somatic mutation or vegetative segregation. The latter conception, originally proposed by BATESON, became out of date, and seems no longer supported with the possible

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\* By somatic segregation, it does not necessarily mean the Mendelian factor segregation in the somatic cells, but it is understood now the occurrence of two dissimilar cells at a somatic cell division, resulting in the formation of chimeras. Chimeric origin of bud variation is, however, conceivable as mere somatic rearrangements of the tissues of a chimera, which is already represented by a definite structure.

exception by the school of LORSY, who denies the fact of mutation and alludes all heritable variations to segregation\*. It was also questioned by the writer if the case can be explained by chimeric formation of the original sport branch, not by means of graft-hybridization, but by mutation occurring in certain tissues of the branch, as suggested by SROUT. The writer's recent study of periclinal chimera in Bizzarria orange brought sufficient evidence to disprove it.\*\* STRASBURGER's suggestion of "Hyperchimera" in mosaic shooting graft-hybrids seems analogical to certain cases of bud-variation, like in willow-leaf Satsuma, but it seems far from similar to the case of Wase. These considerations, by the process of exclusion, bring about a necessary conclusion to approve the theory of factor mutation which occurred vegetatively in the somatic branch tissue.

"Owing to the multiplicity of the characters of Wase, the writer questioned in the previous paper whether these characters are manifold expressions of a single mutating factor, or are expressed by several factors linked together. Evidence brought forward in many cases of factor mutations in plants, made the former view more plausible than the latter. It has been shown also, by EMERSON and others, that several factors can be related independently to an identical mutation. It is therefore highly probable that each case of Wase bud-variation may be caused by the mutation different factors. This might be the explanation of why the resulting Wase strains are slightly different and other much modified strains arise.

"Whether Wase characters are represented by a dominant factor or a recessive one, remained unanalysed. It appears almost impracticable to solve this question. The lack of viable pollen in the Satsuma orange prevents the selfing, and the seeds often fail to develop by defective embryonic development, whenever it is cross-fertilized. Moreover, the well-known phenomenon of apogamy makes it impossible to judge whether the seed obtained by cross pollination is a true hybrid or not. The so-called false hybrid prevails in the Satsuma orange, the original embryo being the mere extension of the nucellar tissue of the mother ovule, entirely replacing the fertilized ovum. Then dominancy is again a guess, but examples show that both dwarfness of plant and early maturing of fruit are generally recessive to normal, and the Wase mutation will possibly be designated by the revelation of *aa* branch on the *Aa* individual. Vegetative reversion is therefore the regaining of heterozygosity *Aa* from the individual *aa* of bud-variation origin.

TERAO recently introduced a fair explanation of "allelomorphic transformation" to solve the similar phenomenon in rice, proving such alteration of allelomorph  $A \rightarrow a$  or  $a \rightarrow A$

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\* LORSY's hypothesis of hybrid origin of all botanical species is unquestionably open to severe criticism, but it is unnecessary to say that the author simply meant that the dissimilar cell structure must have originated from a heterozygous mother cell which is of hybrid origin. It is, however, now conceivable that such a heterozygous cell structure might be originated not only by hybridity but by chromosomal irregularity.

\*\* The author's later publication on Bizzarria<sup>(177)</sup>, published in the Journal of Genetics, did not touch the question whether the chimeric origin of the Wase Satsuma is possible or not. This question is therefore reserved for later discussion.

as possible. It is not a "cross over" nor "deficiency" that makes such alteration of both directions a possibility. The parallelism of mutation and vegetative reversion in the case of Wase Satsuma, as well as in other cases hitherto not explained, finds an excellent interpretation, provided this conception is taken into consideration.

"In the writer's previous paper, it was stated that the vegetative reversion of commercial Aoe Wase\* is very frequent, sometimes attaining to 28 %<sup>1</sup> per cent. Similar reversion was also reported to exist in other kinds of Citrus fruits of bud-variation origin. It was therefore concluded that the new form originated by apparent somatic mutation does not stay constant but shows a strong tendency to revert to its old form. From this conclusion, it can be seen that the bud-variation and the vegetative reversion are not two independent phenomena but a continuous phenomenon, possibly formulated as  $Aa \rightarrow aa \rightarrow Aa$ . The explanation for the continuous allelomorphic transformation  $A \rightarrow a \rightarrow A$  must therefore be sought.

"Unfortunately, time is premature to secure any evidence for a satisfactory explanation. It is thinkable, however, that the allelomorphs are not the embodied substance but are the expressions of the same unit substance functioning differently a different configuration of the constituting elements. Such configuration may be altered by the simple translocation of the components, which can be reversed into the original phase when it is more stable. If factors are thought materially existing, the explanation must be more complicated, allowing assumptions. Further discussion on this problem will be made at some other opportunity."

In 1927, the author<sup>(167)</sup> discussed whether the explanation of the phenomenon by "Chimera" is possible or not. As it is shown in his paper on Bizzarria<sup>(177)</sup>, "sectorial chimera" is not the permanent structure\*\*, while "periclinal chimera" is more common and is rather readily originated not only by graft hybrids, but also by vegetative segregation (or rather, somatic mutation) produced by the division of an apical sub-epidermal cell, as pointed out by NOACK<sup>(84)</sup>. Such periclinals can easily send forth a branch of the original structure by a simple somatic rearrangement of the tissue, thus giving rise to the reverted shoot of the original variety from which the bud variant sprang. This explanation is now rather widely accepted, as shown by BATESON<sup>(9)</sup>, CHITTENDEN<sup>(80)</sup>, and others, especially in interpreting the simple vegetative segregation, such as variegation. EAST<sup>(28)</sup> first suggested the peach-nectarine sport as an example of a periclinal. JONES<sup>(47)</sup> compared the

\* Aoe Wase is an old name of Kawano Wase, sometimes involving Yakushiji Wase.

\*\* See CHITTENDEN, l. c. and SANSOME, F. W. <sup>(100)</sup>, in agreement to the author's view.

author's case of Wase sports with the peach-nectarine case as an identical phenomenon. Both variegation and pubescence look quite like a structural change of cell layers, and the explanation by periclinal chimera is plausible, but the case of Wase Satsuma is more complicated and the change of the character of the fruit runs throughout from core to skin, showing no sign of chimerical construction of the cell layers. We have distinct periclinals between the Satsuma and other *Citrus*, like the Natsudaidai and Kinkôji, in which the innermost layer is affected, yielding juice vesicles of the latter kinds containing distinct Satsuma juice.\* Either the seedling or the root cutting of the Wase Satsuma may present a proof whether it is periclinal or not. It is, however, very difficult to obtain germinal, not apogamic, seeds from such a parthenocarpic fruit as the Satsuma. Furthermore it is extremely hard to raise the Wase Satsuma on its own root and succeed in getting its root cutting. It is hoped these processes will be tried out later. "Hyperchimera" may be quoted as an analogous case, as pointed out by the author<sup>(123)</sup>. At present, the author thinks it rather difficult to explain that the vegetative reversion of the Wase Satsuma is caused by the mere rearrangement of tissue, as in the cases of simple periclinals. After all, even when the Wase character is assumed to be of chimeric origin, its first occurrence must be credited as being initiated by somatic mutation of the apical cell nucleus, and the theory of allelomorphic transformation is still applicable in explaining this possibility.

Being still unsatisfied with the interpretation of Wase bud variation through factor mutation, the author<sup>(172)(1767)</sup> tried to get a better explanation of it through chromosomal mutation. The slight difference of the mutants (strains) of the bud variation Wase Satsumas seemed suggestive of the aneuploid mutants of *Datura*, discovered by BLAKESLEE and BELLING<sup>(13)(14)</sup>, and the author questioned whether the Wase variants are trisomic mutants or not<sup>(176)</sup>. At the author's suggestion, a cytological study was carried out by NAKAMURA<sup>(81)</sup>, and he reached the conclusion given below, after investigating several bud variants of the Wase Satsuma.

\* These chimeras are called "Kobayashi-mikan" by SAMURA (99), and "Kinkôji-unshû" by OKAMOTO. Both from the author's actual study of the fruits.

"The present karyological investigation of the pollen mother cells of Fujii and Yamada Wase Satsumas proved the fact that, there is no difference in their chromosome number as well as in the behavior of the reduction division between the branches originated through bud variation and of the normal branches of the mother plant. The haploid chromosome number in Fujii Wase is nine, showing the basic number of the genus *Citrus*. It is evident that there is no sign of trisomic chromosomal mutation in these strains of the Wase Satsuma."

He further states :

"The successive allelomorphic transformation suggested by Prof. TANAKA, as the cause of Wase mutation is suitable to explain the continuous phenomenon of bud variation and vegetative reversion of the Satsuma orange. It is, however, unwarranted whether Wase characters in many Wase strains are expressed by the several genes which are associated closely to designate the complex mutation, or by a single gene which governs every minute difference existing in the different strains of the Wase Satsuma. It is necessary to accumulate more sufficient data to solve this question, through the study of individuals of the different strains of Wase Satsuma planted under homogenous environmental condition."

The author has seen several tetraploid individuals of Citrus fruits in the grounds of the University of California Citrus Experiment Station at Riverside, under the guidance of Dr. FROST, who published an account of it<sup>(22)(14)</sup>, and he was convinced that there is no similarity between the Wase Satsuma and these orthoploid mutants. These tetraploid Citrus have somewhat contorted leaves and fruits with dispersed oil cell dots, somewhat analogous to those of the Wase Satsuma, but the former shows much difference in the doubled thickness of the leaf lamina and in the fruit rind. The enlargement of pulp vesicles also may be more or less identical, but the former lacks a rich flavor and abundance of juice. Commercially, one is worthless while the other is of utmost use. The difference is too clear to need further discussion.

BAUR<sup>(11)</sup>, after discussing the much better known "Plastid mutation", suggested the possibility of "plasmogenic mutation" first springing out through the change of the "plasmon" other than the chromosomal "genom", in solving the problem of this phenomena which so far has not been satisfactorily interpreted. WETTSTEIN<sup>(22)(23)(24)</sup> has clearly set forth the fact that the morphological difference of plant organs, such as the sporogonium of moss, is determined by the heritable "plasmon". Although no artificial change of the moss plasmon resulted from any

stimulation, BAUR believes that such is possible, and attributes very irregular "capricious" inheritance, induced by Radium or Röntgen ray, extreme temperature, poison, etc., at least partly to plasmogenic mutation. There have been several cases of mutation claimed to be due to certain stimuli, among which the example given by BLARINGHEM is most noted. He claims<sup>(15)(16)</sup> that he succeeded in obtaining two early maturing elementary species of maize, *Zea Mais praecox* and *Zea Mais semi-praecox*, through a mutilation of common maize, *Zea Mais pennsylvanica*. According to our present knowledge, this case is very likely due to plasmogenic mutation induced by the stimulus of traumatism. Such mutants are fairly constant, according to BLARINGHEM, but still are occasionally subject to further mutation. Many other mutants are reported but the most interesting are these early forms. Whether our *praecox* variants of the Satsuma orange are analogous or not, is not known, but it is of interest to know that precocity is obtainable by traumatism. As the writer frequently mentioned, the existence of queer knobs or press-markings just below the starting point of the variation or reverting shoots, and as NORO<sup>(87)</sup> paid much attention to these peculiar signs, it seems as if the branch had received some external stimulus. In the cases of Yamada Wase and Aikawa Wase, the variation branch is unquestionably marked by a wound at the bottom while the branches of Matsuki Wase and Morita Wase evidently spring out from immense teratological, tumor-like swellings, apparently caused by ringing or some other disturbance. Although the evidence is lacking as to whether such a disturbance really causes the variation or not, it looks likely that some connection does exist between the wound and the Wase variation, as their association is very frequent. As STEIN<sup>(119)</sup> points out, the plant receiving modification by stimulus (Radium ray) returns to the normal form even vegetatively, looking identical to the vegetative reversion. It is, therefore, presumable that certain stimuli might have caused plasmogenic mutation in the Satsuma orange plant, giving rise to the early maturity and an increased fruiting capacity, with relatively decreased vegetative vigor. Such a high productive stage may last until some counteracting effect causes the plasmon to return to the ori-

ginal state. This assumption is probably the easiest in interpreting the fact of Wase bud variation and its vegetative reversion, both so frequently occurring in nature.

## GENERAL SUMMARY AND CONCLUSION

(1) The name "Unshû Mikan," now used as the standard name of the Satsuma Orange, is first properly applied in the work of Shôken OKAMURA, dated 1828. The name used in a lost work by Keishi MUSASE dated 1818, appears also to be the same. The earlier names of the Satsuma orange are "Tachibana" of Yanagawa, Tômikan, and Rifujin-kitsu.

(2) The homonymous "Unshû-kitsu" has been known in Japan from the fourteenth century, but judging from the description written during the eighteenth century, many different forms are involved under this name, none of which is applicable to the present Satsuma orange.

(3) The name "Unshû-kitsu" signifies the local name in China, Wen chou fu in Chekiang Province, and as Yen-chih HAN's monograph of Citrus of that place is well-known among Japanese scholars (probably through Shih-chen Li's Pen ts'ao kang mu, which gives high credit to this work), this name must have been adopted to designate any attractive Citrus fruits of Chinese origin then cultivated in Japan.

(4) There is a place in Ôsumi Province which is on record as growing Citrus fruits introduced from Wen chou fu, but the actual survey of the place disproved the presence of the Satsuma orange.

(5) The tradition giving credit to the Korean origin of the "Tachibana" of Yanagawa, a synonym of the Satsuma, is unthinkable since the Satsuma orange did not occur previously in the island of Quelpart, the only Citrus section in Korea.

(6) The discovery of the written record of the Satsuma first introduced from China into Ônakashima of Higo Province, gave an explanation of the name "Ônakashima", a widely applied synonym of the Satsuma in Hizen Province, Nagasaki Prefecture. This local name is now applicable to Nagashima, one of the Amakusa Islands, formerly



included in the same province. Since this place is a seaport connected with the Chinese ports in early days, the original locality which supplied the planting material of the Satsuma orange was sought on the Chinese coast, especially in Chekiang Province, which was most frequently visited by the Japanese when they went to the temple of Tien t'ai shan.

(7) Huang yen, the nearest Citrus district to Tien t'ai shan, was visited by the author, and he found that this is the only locality on the Chinese coast which grows the Japanese Kinokuni and Jimikan and undoubtedly furnished this country with them. Although the Satsuma was not existing there, three species were chosen as the probable mother-forms which gave rise to the Satsuma through chance seedlings, process by which it is possible to produce new species.

(8) As to the history of the cultivation of the Satsuma orange in Japan, the earliest record now accessible dates back about 300 years, but the orange was probably known from still earlier times. Its earliest center of cultivation is limited to Fukuoka and Nagasaki Prefectures, and its gradual movement eastward is proved by the existence of huge trees in the prefectures of Ôita and Ehime. Even in the places of the latest development of the Satsuma industry, plants over 70 years old are occasionally to be found. It was first introduced into America in 1876, where it received the name "Satsuma" in 1878.

(9) Under careful morphological study, the Satsuma characters became very clear. The plant is inerm, having a small number of branches; leaves are large, hanging, with elevated midrib and veins; the almost wingless petiole is rather long. Flower buds are large and long; filaments very short, and the anther more or less caudate-pointed. The fruits are medium-large, flat, oil cell dots uniformly large, rind rather thick and brittle, segments many, central column large, pulp quickly loses acidity, pulp vesicles elongate-netted, with thin membrane, abundant meat, tasting sweet but rather quickly becoming insipid. Seed is usually lacking (parthenocarpic), but if present, it is plump, simply pointed at one end, rather smooth, with pale-green poly-embryo and light-colored tegmen at the charaza part.

(10) Among the Japanese cultivated Citrus fruits, Kunembo (*Citrus nobilis* LOUR.) and Yatsushiro (*Citrus yatsushiro* HORT.) are the nearest, but under close observation they proved to belong to entirely different species. The Satsuma is much nearer to the Chinese Tsaokieh (*Citrus succosa* HORT.), Mankieh (*Citrus tardirefax* HORT.) and Pentitsao (*Citrus succosa* HORT.) in the characters of its fruit.

(11) Botanically speaking, the Satsuma is distinct from any other relatives and is worthy to be regarded as an independent species. The author named it *Citrus unshiu* HORT. in 1923, but it was learned afterwards that MARCOVITCH had published the same name two years before in a very obscure publication written exclusively in the Russian language. Therefore, *Citrus unchiu* MARC. is adopted here as the scientific name of the Satsuma orange.

(12) The first botanical description of the Satsuma orange was given by MIQUEL, based upon the specimen collected by SIEBOLD in Nagasaki, but no new name was proposed by him. ENGLER described *Citrus Aurantium* subsp. *Keonla* ENGL. based upon wrong material, which consisted of a dried specimen of the Satsuma collected by MAXIMOWICZ in Nagasaki.

(13) The True orange of Wen-chou has been identified as the Kunembo, Kinokuni, or Kôji, but the original description of Yen-chih HAN, written in 1178, does not correspond to any of these Citrus. The actual investigation of the Wen-chou orange revealed the fact that it belongs to a new species, subsequently called *Citrus suavissima* HORT. It has no connection with the Satsuma orange, which is called the Wen-chou orange in Japan.

(14) The systematic position of the Satsuma orange, *Citrus unshiu* MARC., is determined to fit in Sect. *Acrumen*, TANAKA, subsec. *Euacrumen* TANAKA of the subgenus *Metacitrus*, TANAKA. The general affinity to the large-fruited members of *Acrumen* cannot be denied, although the habit of the tree, the characters of the leaf, the floral type, and the rough appearance of the fruit show a striking resemblance to Sect. *Aurantium*, TANAKA of Subgen. *Archicitrus*. The fundamental difference existing between these subgenera is in the presence or absence of inflores-

cence. The Satsuma flower has no common peduncle and stands solitarily or fasciated on an axil of the bearing shoot.

(15) Botanical species are divided into distinct categories, the wild species (*Indigen* of L. R. BAILEY) and the horticultural species (*Cultigen* of BAILEY). Both are botanically in the same rank, only differing in their origin, one from the field, the other the garden. The Satsuma, *Citrus unshiu* MARC., belongs to the latter, since its occurrence in the wild state is unknown. Its type seems not to be present at the Sukhum Agricultural Experiment Station, where MARCOVITCH described the species. His name is possibly derived from *Citrus nobilis* var. *unshiu* SWINGLE, and the latter is, in turn nothing but a new combination of the author's *Citrus nobilis* subsp. *genuina* TANAKA. var. *unshiu* TANAKA. The author's original name is based upon definite type-material existing in the author's own herbarium at Taihoku.

(16) In starting the pomological study of the Satsuma orange, the author emphasized the necessity of fixing the definition of "variety" and "strain" employed for investigation. The "horticultural variety" (*Hortivar* of BAILEY), like the "wild variety" (*Indivar* of BAILEY), exists in relation to the type of the species, not with the other varieties, and likewise, "strain" exists only by comparison with the type of the variety, not with the remainder of the strains of the same rank. In this respect, SHAMEL's conception of the strain is abandoned in the present study of the Satsuma orange.

(17) The variety segregation of the Satsuma orange was first proposed by the author in 1912, based upon his actual sampling from representative Satsuma-growing sections in Japan during the period 1909-1911. From this investigation it became clearly known that three leading nursery districts of Japan, i. e., Nakajima section in Owari Province, Ikeda section of Settsu Province, and Tanushimaru section of Chikugo Province, have their own Satsuma varieties, subsequently named by the author in 1918 as "Owari", "Ikeda", and "Zairai", respectively. Two other small localities were also credited in having their own varieties; i. e., "Hira" of Tachima section in Ehime Prefecture, and "Ikiriki" of Nagasaki Prefecture. The "Wase" was also

claimed as a distinct variety in the author's original investigation. These six varieties were pomologically described in 1918 and the names of varieties proposed were adopted and standardized by the American Pomological Society, and are also followed by the Japanese pomologists (MIKI, TOGASHI, etc.) In the present work, the material used for the study was thoroughly presented and the data of the measurements of fruits was given. From the figures showing the comparative flatness (diameter-height index), the difference of each variety was fairly well demonstrated. The validity of using the D/H index as a help in identifying the variety is proved by three years observation on the Ikeda variety. It is showed that the annual deviation of its value per tree within that variety is only  $\pm 5.0711\%$ , while its annual deviation is  $\pm 2.9002\%$ .

(18) Pomological studies conducted in the United States during the years 1917-1918, proved the existence of 6 orchards of Ikeda, 8 orchards of Owari, and 4 orchards of intermediate, provisionally considered Zairai. The average D/H indexes of fruits of these three lots are 1.22, 1.44, and 1.33, respectively.

(19) During the period of 1918-1919, pomological studies of the varieties of the Satsuma orange were conducted, chiefly to re-examine more critically those varieties which had already been worked out, with the additional purpose of finding out larger-fruited strains of each variety. In this study, the validity of three varieties "Ikeda" "Owari" and "Zairai" was first concluded, whereas the "Hira" was also determined almost valid, but the "Ikiriki" became doubtful. The standing of the variety "Wase" was safe, and a clue was found on the occurrence of the Wase character through bud variation.

(20) In order to make the doubtful point clear and to make sure of the possibility of the selection of such a large fruited type as MORI's Owari, the author found the absolute importance of inaugurating a new method of investigating the variety or strain on the basis of individual performance. In the present pomology, the basis of segregating the variety lies in the judgment taken primarily from samples of random picks, but this kind of sampling brings about the danger of getting

only high class individuals, representing far better grades than the average. Since the aim of the present study is not to fulfil a vague demand of the growers to promote the culture of attractive-named varieties, it should be conducted by using as samples those which rigidly represent the average whether good or bad. Moreover, the samples must be handled statically and also strictly botanically, by adopting a uniform method of measuring and describing.

(21) The first important improvement in the method of investigation is to pick out a representative individual and keep its record as fully as possible and to study the individual as often as possible. The samples of fruit must be taken only from that individual; pick the whole crop if possible, or take the whole crop of a single representative branch if it is impossible to use the entire crop of the plant. Standards of judging individual fruits are definitely scheduled and 27 characters of each fruit are recorded in using the standard. The record of the fruit of each lot is tabulated on a separate sheet and that is used as fundamental material for segregating the variety or strain. The botanical description of the tree and the samples of fruit, both of the outside and of the halved surface, gives valuable help in showing the difference. The condition of the orchard, of the tree, of the year, and particularly of the time of investigation, is taken into consideration, which altogether furnishes additional help in making a sound judgment. Series of sketches of fruit samples, including the extremes and the average for each lot, are separately made to make distinction very easy. This new elaborated method was faithfully followed for all investigations conducted after 1919.

(22) Under this new method, the selecting of a new clone (individual) was done with ease, and the segregation of varieties and strains can be successfully made. In 1919, 5 prefectures were visited, where 24 individual trees were chosen for study. In 1920, 43 individual Satsumas were selected for investigation from 9 prefectures, besides 22 lots of Wase trees for special study. In 1921, the work was extended to the Gulf States of the United States, where 20 individual lots were chosen for test. The work was still carried forward in Japan up to

1925, but from 1922 the study was concentrated on finding out Wase variations.

(23) With the application of the new method, the first problem to solve was to find out the proper place of the "Ikiriki" variety. This variety was proved to be identical to Owari, by comparing the crop of the typical Ikiriki plant at the Nagasaki Agricultural Experiment Station with that of the Owari plant introduced into Ikiriki village. It was confirmed also by comparing two trees at the Nagasaki Station, one a typical "Ikiriki", the other a small "Owari" plant introduced from Idzumi Province, Osaka Prefecture. Additional "Ikiriki" material was also investigated at Kagoshima Prefecture, leading to the same conclusion.

(24) The second achievement was the segregation of the Ikiriki-Owari variety and the so-called "Kogakei" growing in the same locality. With the comparison of the Ikeda and the Zairai individuals, the identities of Kogakei and Zairai were established. Further study showed that the Kogakei-Zairai frequently provides a fluted strain, but no large-fruited strain was found, while Ikiriki Owari includes very large-fruited clones, which were subsequently named "Tanaka's Kashima", "Matsuo's Sase Nakashima", etc. Additional studies of Ikiriki-Owari individuals proved the superiority of the strain coming from Kashima Island.

(25) The next undertaking was to make a clear distinction between the Hira variety and the Owari, which was carried out satisfactorily. Moreover, two superior individual clones, named "Gold Medal" and "Excelsior", were isolated. It was also noted that certain individuals, like YAKUSHIJI's "Perfect" clone, approach very closely to Hira, although it belongs definitely to Owari. The origin of the Hira variety is thus suggestive of a descent from Owari, which has long been in existence in the locality where it grows. A full record of very old trees of both varieties with their crops is also presented for comparison.

(26) The next important advance in recording the crops by means of individual performance, was to mark out the distribution of known varieties. As was already mentioned, the Owari variety has its origin at least in Nagasaki Prefecture, but in its natural course in reaching

Aichi Prefecture, it should be present in places *en route*, or perhaps distributed still farther on. From the investigation of individual trees, its existence was proved in Ôita, Ehime, Hiroshima, Ôsaka, and Wakayama, and Prefectures as far east as Shizuoka and Kanagawa. The individual plants used for study are older than the beginning of the activity of the Owari nurseries thereby proving that these materials employed are not of Aichi origin.

(27) The Zairai variety flourishes most in Fukuoka Prefecture, where its difference from the Owari variety is distinct as seen in the result of the comparison of a representative plant of the former with an introduced plant of the latter from Aichi Prefecture (at Hara's orchard in Yoshii). It was proved that Zairai trees of age exist in Ôita Prefecture, but this variety is extinct on the western coast of Shikoku Island, and does not reach the eastern nursery districts. It seldom occurs in places east of Ôsaka.

(28) In Ôsaka Prefecture, a state of mixture of varieties was noticed, although this region makes a special choice of the Ikeda variety for the purpose of storage. Besides Owari individuals existing for many years before the Idzumi nurseries (highly recommending the Owari variety) became active, a small percentage of Zairai was detected mixed among the Ikedas. This leads to the assumption that the latter sprang from the former, and was then selected for its better quality. Mixtures of the Zairai variety seem to be limited to old orchards, which were probably planted before segregation was perfected.

(29) Strains of the Ikeda variety were also isolated, such as Willow-leaf, unproductive, and fluted. Wrinkled and variegated strains were found both in the Ikeda and the Owari varieties. The "fluted" character is attributed to the change made when round-fruited varieties make abnormal side expansion, and thus we see "fluted Zairai" and "fluted Ikeda". The "wrinkled" variation also arises because of an abnormal condition of the tree.

(30) A new variety, called "Maru", was isolated from Zairai in a mountain region of Ôita Prefecture.

(31) By the work conducted in the United States on the individuality basis, it was concluded that the distinction between the varieties of Owari and Ikeda is enough clear, even under conditions so widely different from those in Japan. It was also found that the directly-imported Owari individuals from Aichi Prefecture show a slight difference from those of early importation. The latter, generally called "Glen St. Mary Owari", is slightly inferior, but is not so poor as the Zairai, often showing a remarkable quality of the fruit. It is unquestionably a strain of Owari which did not pass through the severe testing and selection that the former had received. Variations of both Owari and Ikeda varieties are also found in the same territory.

(32) Taking part in the discovery of the economic value of the Wase variety of the Satsuma orange, the author first made an extensive study on the history and character of this particular orange, and its true nature, together with an interesting mode of recognizing it, was fully revealed. The commercial Wase variety or the Wase variety type called by the author "Kawano Wase" for convenience, has four original individual grafted plants, and their products were separately investigated on the individuality basis, but no difference between them was found. The examination of Wase fruits from commercial plantings also showed no particular difference from those of the original plants.

(33) Another still larger grafted plant of similar nature was found in the original locality of Kawano Wase and was termed "Yakushiji Wase". The relation between the individual and the original plants of Kawano Wase is unknown, so that identifying these two clones as a single strain is impossible. The basal character of the fruit of the former seems not quite identical with the latter. The Yakushiji Wase has contributed nothing to the present development of the Wase Satsuma industry.

(34) In order to verify the complaint that the Wase bud does not come true to type when vegetatively propagated, the author examined 15 sample trees of Wase (Kawano Wase) planted at the Tsukumi Station, Ôita-ken, supposed to have come from a reliable source. The individual performance test showed that 3 plants out of 14 tested (21.4 %) were .



not Wase. This result agrees with the common belief of the grower that no solid Wase block is obtainable and that such planting is always disturbed by a mixture of ordinary Satsumas very near Owari.

(35) An attentive observation of Wase plants showed that certain trees are dual, having one or more branches of Owari, besides the Wase limbs. It became clear that such plants were propagated as Wase and kept their character throughout, except for such "sporting" branches of Owari character which break the uniformity. Fruits of these took kinds of branches, studied statistically, proved this fact, showing the exact contrast lying between these two varieties. Although the original trees of Kawano Wase showed no such variation, some individuals of the second and third generation propagated from them were distinctly dimorphic.

(36) Four series of large-scale investigations were then conducted at Tsukumi and Ôchô, running over all the plants of four entire orchards. The result of the study, made at two different times, is summarised in

		per cent	
		1920	1924
1) Per cent of Owari buds vs. total buds originally intended to result in Wase only	Orchard A	37.75	—
	Orchard B	54.84	53.76
	Orchard C	46.72	41.53 (43.62)*
	Orchard D	—	32.72
1) Per cent of dimorphic plant vs. total Wase plants	A	14.75	—
	B	14.29	22.73
	C	27.19	30.64 (32.88)*
	D	—	52.70
3) Per cent of dimorphic plants vs. total Satsuma buds (Wase and Owari, originally intended to result in Wase only)	A	9.18	—
	B	6.45	10.75
	C	12.30	18.64 (19.42)*
	D	—	33.64

Synopsis: Orchard A., SAKAMURA's orchard at Tsukumi; B., HATSUMORO's orchard at Ôchô; C., ÔNO's orchard at Ôchô; D., ASAUMI's orchard at Ôshô.

\*) Figures when 8 plants not studied in 1920 were taken into consideration.

the following table :

This shows the increase of the variation during the course of three years so that the percentage will increase when the trees get still older, that is, the variability does not stay constant. The meaning of the variability is considered in connection with the occurrence of the Wase character through bud variation. This kind of frequent sporting of Wase plants is therefore interpreted as "vegetative reversion" often found in mutant plants of various kinds.

(37) The first example of bud variation originating Wase characters is given in the case of "Higuchi Wase" found at Tsukumi, Ôita Prefecture. From 1920, repeated study was made by the author to give the details of fruits of both variation branches and normal limbs. This led to the conclusion that the plant is Owari and the crop on the variation limb represents a new strain of Wase, slightly different from that of Kawano Wase, although they are very closely related. From this conclusion, a generalization of "Wase characters" was found to be drawn easily, so that the criterion bringing forth the bud variation origin of Kawano Wase is accepted by the analogous fact actually witnessed in the case of Higuchi Wase. It is also proved that the new Wase character can be perpetuated by vegetative propagation, since the crop of second generation trees, investigated repeatedly, is thoroughly identical to that to the variation branch.

(38) The second instance of the occurrence of a new Wase strain, called "Hozaki Wase" from Asahata in Shidzuoka-ken through bud variation, emphasized the validity of the above given criterion, whereas the new fact endorsed the readiness of such variation. By repeated individuality tests, it was found that Hozaki Wase is very different from the Wase type by having very much rounded fruit with exceedingly raised calyx tubes, tight skin and pithy segments, although the early maturity, color and oil cell dots of the rind, and the coarse pulp vesicles remain constant as in a Wase strain. This peculiarity was also found to be perpetuated by vegetative propagation and it comes from the character of the normal part of the original tree, which corresponds to that of the Ikeda variety. This fact tells us that the difference, of the

variety or probably more minute differences, reflect upon the character of the bud mutants, thereby initiating the strain-difference of the resultant Wase clons.

(39) Such individuality of new Wase strains was definitely demonstrated by still further discoveries of independent bud variations. These are "Shintani Wase" from Hisatomo, Hiroshima-ken, having fruits similar to the type, but flatter and thinner skinned; "Sueoka Wase" from Ôchô, Hiroshima-ken, having equal shape but very large and better-tasting fruits with extremely thin skin; "Ishikawa Wase" from Toyodamura, Shidzuoka-ken, having very large attractive fruits containing rather insipid pulp; "Horie Wase" from Nishimashidzu, Shidzuoka-ken, having rather small fruits of fair quality; and so on. Although the above given four Wase strains, successively discovered, have arisen from the single variety "Owari", their strain-differences can be easily attributed to the difference of the individuality of the mother plants from which they sprang. In the case of Sueoka Wase, the mother plant is already lost, but it is safe to conclude that the original variation occurred about 100 years ago; that is to say the Wase bud variation is the inevitable nature of the Satsuma, occurring from time to time throughout its phylogenetic course. It is later learned that any variety of the Satsuma can also produce a similar variation.

(40) Up to 1921, cases of bud variations originating Wase characters were still rare, but as soon as the author started work at Mikkabi, Inasa-gun, Shidzuoka-ken, it became certain that such variation is very common and the technique of finding these cases is comparatively easy if the observer watches attentive. The first example of the Wase from Mikkabi is the "Nagata Wase", known since 1920 but remaining obscure until 1923, when an active survey was commenced.

(41) Besides Nagata Wase, Yamada Wase, Shimidzu Wase, Natsume Wase, Takegami Wase, Suzuki Wase, Fujii Wase, Morita Wase, Sato Wase, etc, were discovered within the boundary of the township, during the period 1923 and 1926. The finding of these bud variations originating Wase characters proved to be endless. As a matter of fact such finding has its own meaning when the relative value of each strain

is made clear by another series of cultural experiments, planting such strain side by side, for a reasonable period of time spent in observation. Such work is undoubtedly beyond the aim of the present study, and the author only tried here to present most faithfully the characteristics of each strain.

(42) The mother-varieties from which these independent Wase bud variations were isolated consist of Owari, Ikeda, and Zairai, and the individuality of these Wase strains is well kept along with some characters of the mother-type. For instance, the excellent quality of SUZUKI's Owari individual is reflected in its Wase fruits, also the small, round-fruited character of MORITA's Ikeda plant is repeated in the Morita Wase fruits, and even such a minute character as the enlarged disk-ring of the fruit of TAKEGAMI's Owari plant is faithfully copied in the Takegami Wase fruits. This kind of minute speciality has never been reported in any other cases of bud variation in fruit trees.

(43) Additional Wase bud variations were recorded by the author during the same period from the prefectures of Kanagawa, Nagasaki, Ôita, Fukuoka, Hiroshima, Shidzuoka, and Wakayama. The most interesting of all are those Zairai Wase strains, like Miyagawa Wase and Mikami Wase, both found in Fukuoka Prefecture. They have large round fruits with thick durable skin giving a capacity for keeping well which is lacking in most of the Owari Wases. Other unusual features met with in these new Wase strains are fluted fruits as shown in Osugi Wase, found in Ôita Prefecture, and the fruit of the Ichikawa Wase, which has a prominent navel, often sticking out from the surface. In the latter case, it was found that the peculiarity can be perpetuated by the vegetative propagation.

(44) Other interesting discoveries are the occurrence of Ikeda Wases. Both Ueno Wase and Kubo Wase have distinctly sprung from the Ikeda variety, and their fruits are small, round, and somewhat sinuate-based, entirely unlike the Wase variety type.

(45) In 1920, the author studied a giant-fruited Satsuma plant in Shidzuoka Prefecture, and he thought the production of this anomaly due to the effect of girdling because the branch bearing these gigantic

fruits has a very large swelling at its base. Vegetative propagation from that branch at Okitsu brought the repetition of similar large fruits, and it became necessary to call this variant "Matsuki Wase". The giant fruit has a flat outline, thick rind, large central column, extremely coarse pulp vesicles, and early ripening juice. This is the only Wase strain which has such a large central column, and that point made the author at first discard it from the Wase group.

(46) Another unusual bud variation bringing forth the character of early maturing is here called "Hirami Satsuma", because the morphological character of the fruits is entirely different from the Wase variety type, and thereby it does not deserve the name "Wase". The Yamamoto Hirami Satsuma has small, very flat fruits with an excavated area around the stem end, and it has a very large central column and worthless acidulous pulp, very finely-grained. The similar "Tsuda Hirami Satsuma" is a decidedly early coloring strain of the same variety, but lacks the excavated area at the base. It is a grafted plant which bears this peculiarity but is supposed to be of bud variation origin. As NORO founds still other strains of the same character, it is concluded that these series of small, flat-fruited types of more or less early maturing form a variety "Hirami", a very distinct variety of bud variation origin.

(47) The fact which was revealed by the discoveries of the Wase bud variation, led to a strong belief on the part of the plant-breeder that very useful characters can be originated by that process. JONES, in his text-book<sup>(7)</sup>, quoted the author's discovery in the following passage :

"TANAKA reports the occurrence of a valuable variation in the Satsuma orange in Japan. This has been widely propagated as a new variety and differs from the original stock from which it came in larger size of fruit, smoother rind, earlier maturing, sweeter juice, and greater productiveness. This is a really remarkable instance of a bud variation producing such manifold effects of a progressive nature."...

(48) Besides the association of manifold characters arising by a single mutation, so to speak, the strong tendency to revert to the original stock found in Kawano Wase, makes this case of vegetative variation very difficult to interpret. Experimental study through progeny testing,

as employed in ordinary genetical trials, does not apply to the Satsuma orange, being disturbed by the presence of pollen sterility, parthenocapy, and apogamic seed formation. Moreover, the species is extremely difficult to raise on its own root and root-cutting is almost impossible. These difficulties prevent any work being done to see if the variation is actually caused by a factor mutation or by chimerical process. Cytological study conducted by NAKAMURA under the author's supervision, also disproved that the variation is due to a chromosomal (heteroploid) mutation. The effect of stimulation which causes plasmogenic mutation, is also considered in connection with the so-called mutation by traumatism, as a peculiar swelling or a wound frequently takes place in the mutating or reverting branch.

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## EXPLANATION OF FIGURES

### PL. I.

- Fig. 1. A leaf of Kunembo (*Citrus nobilis* LOUR.) (reduced)\*
- Fig. 2. A leaf of Yatsushiro (*Citrus yatsushiro* HORT.) (reduced)\*
- Fig. 3. A leaf of Satsuma (*Citrus unshiu* MARC.) (reduced)\*
- Fig. 4. Flower buds of (a) Kunembo, (b) Yatsushiro, and (c) Satsuma. (natural size)

### PL. II.\*\*

- Fig. 1. Kogakei-Zairai from Nagasaki Agr. Exp. Stat., Lot. No. 1 of 1919 (Table 21).
- Fig. 2. Ikiriki-Owari from Nagasaki Agr. Exp. Stat., Lot. No. 2 of 1919 (Table 22).
- Fig. 3. Owari from KOPAYASHI's orchard at Ikiriki, Lot. No. 7 of 1919 (Table 23).
- Fig. 4. Owari from Nagasaki Agr. Exp. Stat., Lot. No. 4 of 1919 (Table 24).

### PL. III.

- Fig. 1. Ikiriki-Owari from Kōkwaen orchard at Kagoshima, Lot. No. 18 of 1919 (Table 25).
- Fig. 2. Owari from Hōkwaen orchard at Kagoshima, Lot. No. 21 of 1919 (Table 26).
- Fig. 3. Kogakei-Zairai from BURŌ's orchard at Ikiriki, Lot. No. 23 of 1919 (Table 27).
- Fig. 4. The same, Lot. No. 62 of 1920 (Table 28).

### PL. IV.

- Fig. 1. Kogakei-Zairai from HIRAKIDA's orchard at Ikiriki (Kashima), Lot. No. 63 of 1920 (Table 42).
- Fig. 2. Ikeda from MORIGUCHI's orchard at Ikiriki, Lot. No. 10 of 1919 (Table 29).
- Fig. 3. Another Ikeda from the same orchard, Lot. No. 56 of 1920 (Table 30, *pro parte*).
- Fig. 4. Kogakei-Zairai from MIZOMOTO's orchard (eastern tree) at Ikiriki, Lot. No. 37 of 1920 (Table 35).

### PL. V.

- Fig. 1. Zairai from Anchōji ground near Tanushimaru, Lot. No. 22 of 1919 (Table 31).
- Fig. 2. Fluted Kogakei-Zairai from Nagasaki Agr. Exp. Stat., Lot. No. 3 of 1919 (Table 32).
- Fig. 3. Kogakei-Zairai from MIZOMOTO's orchard (north-eastern tree) at Ikiriki, Lot. No. 34 of 1920 (Table 36).

### PL. VI.

- Fig. 1. Kogakei-Zairai from MIZOMOTO's orchard (initial tree) at Ikiriki, Lot. No. 8 of 1919 (Table 33).
- Fig. 2. The same, Lot. 36 of 1920 (Table 34).
- Fig. 3. Fluted Kogakei-Zairai from TANAKA's orchard at Ikiriki, Lot. No. 33 of 1920 (Table 38).

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\* These three figures of leaves are reduced in equal scale.

\*\* The fruits presented in PL. II—PL. XLVII are exact side-views of representative (in large lots) or total (in small lots) fruits of individual trees studied statistically. In large lots, they represent the three largest and the three smallest fruits with interlinked ones either normal in shape, or extremely abnormal, showing the limit of variation.

## PL. VII.

- Fig. 1. Kashima individual of Ikiriki-Owari from the same orchard, Lot No. 6 of 1919 (Table 37).  
 Fig. 2. Sase Nakashima individual of Ikiriki-Owari from MATSUO's orchard at Ikiriki (Sase), Lot No. of 1920 (Table 39).

## PL. VIII.

- Fig. 1. The same individual (PL. VII, fig. 2), Lot No. 111 of 1924 (Table 40).  
 Fig. 2. Ikiriki-Owari from HIRAKIDA's orchard at Ikiriki (Kashima), Lot. No. 32 of 1920 (Table 41).  
 Fig. 3. Ikiriki-Owari on sour stock from NISHIURA's orchard at Ikiriki (Kashima), Lot No. 28 of 1920 (Table 43).

## PL. IX.

- Fig. 1. Oldest Hira from KAGAYAMA's orchard at Tachima, Lot No. 9 of 1919 (Table 44).  
 Fig. 2. Owari from the same orchard, Lot No. 38 of 1920 (Table 45).  
 Fig. 3. "Gold medal" individual of Hira from YAKUSHIJI's orchard at Tachima, Lot No. 24 of 1919 (Table 46).  
 Fig. 4. The same, Lot No. 164 of 1925 (Table 47).

## PL. X.

- Fig. 1. "Excelsior" individual of Hira from the same orchard, Lot No. 49 of 1920 (Table 48, first pick).  
 Fig. 2. The same, Lot No. 50 of 1920 (Table 48, second pick).  
 Fig. 3. "Perfect" individual of Owari from the same orchard, Lot No. 51 of 1920 (Table 49).  
 Fig. 4. "Gold medal" (extra material, not mentioned in the text), Lot. No. 148 of 1924 (three fruits only).

## PL. XI.

- Fig. 1. Zairai from Kōkwaen orchard at Kagoshima, Lot No. 17 of 1919 (Table 50).  
 Fig. 2. Owari (over-ripe) from HARA's orchard at Yoshii, Lot No. 11 of 1919 (Table 51).  
 Fig. 3. Zairai (huge tree) from T. KAWANO's orchard at Aoe, Lot No. 40 of 1920 (Table 52).

## PL. XII.

- Fig. 1. Owari, called "small Tsukumi local" from SUEOKA's orchard at Ōchō, Lot No. 14 of 1919 (Table 53).  
 Fig. 2. Owari, called "large Tsukumi local" from the same orchard, Lot No. 16 of 1919 (Table 54).  
 Fig. 3. Owari, called "Ōchō local" from the same orchard, Lot No. 18 of 1919 (Table 55, first pick).

## PL. XIII.

- Fig. 1. The same as the preceding, Lot No. 15 of 1919 (Table 55, second pick).  
 Fig. 2. Owari (reversion) from Nagasaki Agr. Exp. Stat., Lot No. 5 of 1919 (Table 56).  
 Fig. 3. Owari from T. YAKUSHIJI's orchard at Tachima, Lot No. 39 of 1920 (Table 57).  
 Fig. 4. Owari from KATAHIRA's orchard at Iwara, Lot No. 46 of 1920 (Table 58).

## PL. XIV.

- Fig. 1. Owari from TOKIWA's orchard at Yoshihama, Lot No. 41 of 1920 (Table 60).  
 Fig. 2. Owari from AKASAKA's orchard at Yamataki, Lot No. 47 of 1920 (Table 61).

Fig. 3. Owari from KAWAKAMI's orchard at Yamataki, Lot No. 24 of 1920 (Table 62, first half).

Fig. 4. The same, Lot No. 25 (Table 62, second half).

PL. XV.

Fig. 1. Owari from T. SUZUKI's orchard at Mariko, Lot No. 45 of 1920 (Table 59).

Fig. 2. Owari on Yuzu stock from the same orchard, Lot No. 26 of 1920 (Table 63).

Fig. 3. Owari from MINAMI's orchard at Yamataki Lot No. 43 of 1920 Table 64).

Fig. 4. Wrinkled Ikeda from OGATA's orchard at Ikiriki, Lot No. 12 of 1919 (Table 66).

PL. XVI.

Fig. 1. Wrinkled Owari from Hôkwaen orchard at Kagoshima, Lot No. 19 of 1919 (Table 67).

Fig. 2. Tree A Ikeda (normal) from Wakayama Agr. Exp. Stat. at Tadono, Lot No. 57 of 1920 (Table 68).

Fig. 3. Tree A Ikeda (variegated) from the same place, Lot No. 58 of 1920 (Table 69).

Fig. 4. Tree B Ikeda (normal) from the same place, Lot No. 59 of 1920 (Table 70).

Fig. 5. Tree B Ikeda (variegated) from the same place, Lot No. 60 of 1920 (Table 71).

Fig. 6. Ikeda (normal) from M. GORYÔDA's orchard at Ôchô, Lot No. 54 of 1920 (Table 72).

PL. XVII.

Fig. 1. Ikeda (willow-leaf) from the same orchard, Lot No. 66 of 1920 (Table 73).

Fig. 2. Ikeda (willow-leaf) from I. YAKUSHIJI's orchard at Tachima, Lot No. 67 of 1920 (Table 74).

Fig. 3. Ikeda (willow-leaf) from S. SUGIYAMA's orchard at Iwara, Lot No. 65 of 1920 (Table 75).

Fig. 4. Ikeda (normal) from NARIKAWA's orchard at Miyabara, Lot No. 69 of 1920 (Table 76).

Fig. 5. Ikeda (willow-leaf) from the same orchard, Lot No. 68 of 1920 (Table 77).

PL. XVIII.

Fig. 1. Ikeda (unproductive) from Hôkwaen orchard, Lot No. 20 of 1919 (Table 78).

Fig. 2. Fluted Ikeda (North branch) from KAWAKAMI's orchard at Yamataki, Lot No. 52 of 1920 (Table 80).

Fig. 3. The same (South branch), Lot No. 53 of 1920 (Table 81).

Fig. 4. Ikeda from NAKAMURA's place at Obama, Lot No. 61 of 1920 (Table 82).

Fig. 5. New variety "Maru" (original tree) from B. KAWANO's orchard at Aoe (Kadzu-ragahata), Lot No. 64 of 1920 (Table 83).

PL. XIX.

Fig. 1. Owari from HUNTER's tract of REYNOLDS' orchard at Bay View, Lot No. 71 of 1921 (Table 84).

Fig. 2. Owari from BURGHARDT's orchard at Foley, Lot No. 73 of 1921 (Table 86).

Fig. 3. Owari (random pick from bins) from the POTTER Tract, Grand Bay, Lot No. 76 of 1921.

Fig. 4. Owari (representative individual) from HEINRICH Block of the same tract, Lot No. 77 of 1921 (Table 88).

Fig. 5. Owari from ILETT's orchard at Fowl River, Lot No. 79 of 1921 (Table 89).

PL. XX.

Fig. 1. Owari (Glen St. Mary) from SLEEP's orchard at Irvington, Lot No. 82 of 1921 (Table 90).

Fig. 2. Owari (Glen St. Mary) from PENNEL's orchard at Irvington, Lot No. 83 of 1921 (Table 91).

Fig. 3. Owari (of unknown parentage) from the CLARK Ranch at Churra Vista, California, Lot No. 84 of 1921.

Fig. 4. Ikeda from DAVIS's orchard at Irvington, Lot No. 85 of 1921 (Table 92).

#### PL. XXI.

Fig. 1. Kawano Wase (original tree 2) from T. KAWANO's orchard at Aoe, Lot No. 2 of 1920 (Table 94).

Fig. 2. Kawano wase (original tree 1) from the same orchard, Lot No. 123 of 1924 (Table 95).

Fig. 3. Kawano Wase (original tree 2) from the same orchard, Lot No. 121 of 1924 (Table 96).

Fig. 4. Kawano Wase (original tree 3, initial growth) from the same orchard, Lot No. 122 of 1924 (Table 97).

#### PL. XXII.

Fig. 1. Kawano Wase (original tree 3, top-worked) from the same orchard, Lot No. 124 of 1924 (Table 98).

Fig. 2. Kawano Wase (original tree 4) from the same orchard, Lot No. 120 of 1924 (Table 99).

Fig. 3. Owari from the same orchard, Lot No. 119 of 1924, (Table 100).

Fig. 4. Yakushiji Wase (original tree) from YAKUSHIJI's orchard at Aoe, Lot No. 181 of 1926 (Table 104).

#### PL. XXIII.

Fig. 1. Kawano Wase from HATSUMOTO's orchard at Ôchô, Lot No. 1 (first pick) of 1920 (Table 110).

Fig. 2. The same (second pick). (Table 111).

Fig. 3. Shintani Wase (original tree) from SHINTANI's orchard at Hisatomo, Lot No. 5 of 1920.

Fig. 4. Kawano Wase from MAMYÔ's orchard at Ôchô, Lot No. 4 of 1920 (*pro parte*) (Table 113).

Fig. 5. Owari (reversion) from the same tree, Lot No. 4 of 1920 (the rest) (Table 114).

#### PL. XXIV.

Fig. 1. Higuchi Wase (original tree) from HIGUCHI's orchard at Tsukumi, Lot No. 21 of 1920 (Table 118).

Fig. 2. Higuchi Wase (second generation 1) from the same orchard, Lot No. 22 of 1920 (Table 119).

Fig. 3. Higuchi Wase (original tree) from the same orchard, Lot No. 120 of 1924 (Table 120).

Fig. 4. Higuchi Wase (second generation 1) from the same orchard, Lot No. 121 of 1924 (Table 121).

#### PL. XXV.

Fig. 1. Higuchi Wase (second generation 2) from the same orchard, Lot No. 122 of 1924 (Table 122).

Fig. 2. Higuchi Wase (original tree) from the same orchard, Lot No. 183 of 1926 (Table 123).

Fig. 3. Owari (original bud variation tree) from the same orchard, Lot No. 23 of 1920 (Table 125).

Fig. 4. Hozaki Wase (original tree) from HOZAKI's orchard at Asahata, Lot No. 15 of 1920 (Table 126).

## PL. XXVI.

- Fig. 1. Hozaki Wase (second generation 1) from the same orchard, Lot No. 16 of 1920 (Table 127).
- Fig. 2. Hozaki Wase (second generation top-worked) from the same orchard, Lot No. 17 of 1920 (Table 128).
- Fig. 3. Hozaki Wase (second generation 4) from Okitsu Hort. Exp. Stat., at Okitsu, Lot No. 18 of 1920 (Table 129).
- Fig. 4. Hozaki Wase (second generation 1) from HOZAKI's orchard at Asahata, Lot No. 128 of 1924 (Table 130, *pro parte*).
- Fig. 5. Hozaki Wase (second generation 2) from the same orchard, Lot No. 129 of 1924 (Table 130, *pro parte*).

## PL. XXVII.

- Fig. 1. Hozaki Wase (second generation 3) from the same orchard, Lot No. 130 of 1924 (Table 130, *pro parte*).
- Fig. 2. Ikeda (original bud variation tree) from the same orchard, Lot No. 16 of 1920 (Table 131).
- Fig. 3. Shintani Wase (second generation 1) from SHINTANI's orchard at Hisatomo, Lot No. 7 of 1920 (Table 132).

## PL. XXVIII.

- Fig. 1. Shintani Wase (second generation 2) from the same orchard, Lot No. 8 of 1920 (Table 133).
- Fig. 2. Owari (original bud variation tree) from the same orchard, Lot No. 6 of 1920 (Table 135).
- Fig. 3. Sueoka Wase (original tree) from SUEOKA's orchard at Ôchô, Lot No. 9 of 1920 (Table 136, *pro parte*).

## PL. XXIX.

- Fig. 1. Sueoka Wase (original tree), same as above, Lot No. 147 of 1924 (Table 131).
- Fig. 2. Owari (a part of original tree), from the Sueoka Wase tree, Lot No. 148 of 1924 (Table 138).
- Fig. 3. Ishikawa Wase (original tree) from ISHIKAWA's orchard at Toyoda, Lot No. 11 of 1920 (Table 139).

## PL. XXX.

- Fig. 1. Same as above, Lot No. 125 of 1924 (Table 140).
- Fig. 2. Owari (original bud variation tree) from the same orchard, Lot No. 12 of 1920 (Table 141).
- Fig. 3. The same, Lot No. 131 of 1924 (Table 142).

## PL. XXXI.

- Fig. 1. Horie Wase (original tree) from HORIE's orchard at Nishimashidzu, Lot No. 13 of 1920 (Table 143).
- Fig. 2. Owari HORIE's (original bud variation tree), Lot No. 14 of 1920 (Table 144).
- Fig. 3. Nagata Wase (original tree) main limb, from NAGATA's orchard at Mikkabi, Lot No. 100 of 1923 (Table 146, *pro parte*).
- Fig. 4. The same, southern limb, Lot No. 100 of 1923 (Table 146, *pro parte*).
- Fig. 5. The same, eastern hanging limb, Lot No. 100 of 1923 (Table 146, *pro parte*).
- Fig. 6. The same, whole limbs of the Wase, Lot No. 136 of 1924 (Table 149).

## PL. XXXII.

- Fig. 1. Nagata Wase (second generation) from NAGATA's orchard, Lot No. 101 of 1923 (Table 147).

Fig. 2. Nagata Wase (second generation 2) from T. SATÔ's orchard at Mikkabi, Lot No. 102 of 1923 (Table 148).

Fig. 3. Nagata Wase (second generation 1) from NAGATA's orchard, Lot No. 134 of 1924 (Table 150).

PL. XXXIII.

Fig. 1. Nagata Wase (second generation 3) from the same orchard, Lot No. 135 of 1924 (Table 151).

Fig. 2. Nagata Wase (second generation 3) from the same orchard, Lot No. 168 of 1925 (Table 152).

Fig. 3. Nagata Wase (second generation 4), same as above, Lot No. 187 of 1926 (Table 153).

Fig. 4. Owari? (original bud variation tree) from NAGATA's orchard at Mikkabi, Lot No. 165 of 1925 (Table 154).

PL. XXXIV.

Fig. 1. Yamada Wase (original tree) from YAMADA's orchard at Mikkabi, Lot No. 103 of 1923.

Fig. 2. Same as above, Lot No. 140 of 1924 (Table 155).

Fig. 3. Zairai (YAMADA's original bud variation tree), Lot No. 107 of 1924 (Table 156).

Fig. 4. Shimidzu Wase (original tree) from SHIMIDZU's orchard at Mikkabi, Lot No. 104 of 1923, (Table 157).

Fig. 5. Same as above, Lot No. 137 of 1924 (Table 158).

PL. XXXV.

Fig. 1. Same as above, Lot No. 174 of 1925 (Table 159).

Fig. 2. Same as above, Lot No. 197 of 1926 (Table 160).

Fig. 3. Owari (SHIMIDZU's original bud variation tree), Lot No. 105 of 1923 (Table 161).

Fig. 4. Same above, Lot No. 138 of 1924 (Table 162).

PL. XXXVI.

Fig. 1. Same as above, Lot No. 175 of 1925 (Table 163).

Fig. 2. Takahashi Wase (original tree) from TAKAHASHI's orchard at Kawamura, Lot No. 96 of 1923 (Table 164).

Fig. 3. Same as above, Lot No. 117 of 1924 (advance pick).

Fig. 4. Same as above, Lot No. 126 of 1924 (Table 165).

PL. XXXVII.

Fig. 1. Owari (TAKAHASHI's original bud variation tree), Lot No. 92 of 1923 (Table 166).

Fig. 2. Same as above, Lot No. 153 of 1925 (Table 167).

Fig. 3. Miyagawa Wase (original tree) from Dr. MIYAGAWA's garden at Shirouchi, Lot No. 114 of 1923 (Table 168).

Fig. 4. Same as above, Lot No. 126 of 1924 (Table 169).

PL. XXXVIII.

Fig. 1. Miyagawa Wase (second generation) from the same garden, Lot No. 127 of 1924 (Table 170).

Fig. 2. Zairai (MIYAGAWA's original bud variation tree) from the same garden, Lot No. 115 of 1923 (Table 171).

Fig. 3. Same as above, Lot No. 163 of 1924 (Table 172).

Fig. 4. Aikawa Wase (original tree) from AIKAWA's orchard at Ikiriki, Lot No. 108 of 1923.

Fig. 5. Owari (AIKAWA's original bud variation tree), Lot No. 109 of 1923 (Table 173).

PL. XXXIX.

Fig. 1. MATSUDA Wase (original tree) from MATSUDA's orchard at Azamui, Lot No. 103 of 1923.

Fig. 2. Owari (MATSUDA's original bud variation tree), Lot No. 116 of 1924 (Table 174).

Fig. 3. Natsume Wase (original tree) from K. NATSUME's orchard at Mikkabi, Lot No. 156 of 1924 (Table 175).

Fig. 4. Ikeda (NATSUME's original bud variation tree), Lot No. 155 of 1924 (Table 176)

Fig. 5. Shin Natsume Wase (original tree) from K. NATSUME's orchard (Borutō plot) at Mikkabi, Lot No. 167 of 1925 (Table 177).

PL. XL.

Fig. 1. Owari (NATSUME's Shin Natsume Wase original bud variation tree), Lot No. 171 of 1925 (Table 178).

Fig. 2. Takegami Wase (original tree) from TAKEGAMI's orchard at Mikkabi, Lot No. 139 of 1924 (Table 179).

Fig. 3. Same as above, Lot No. 169 of 1925 (Table 180).

Fig. 4. Same as above, Lot No. 191 of 1926 (Table 181).

Fig. 5. Owari from TAKEGAMI's original bud variation tree, Lot No. 158 of 1924 (Table 182).

PL. XLI.

Fig. 1. Same as above, Lot No. 170 of 1925 (Table 183).

Fig. 2. Same as above, Lot No. 190 of 1926 (Table 184).

Fig. 3. Suzuki Wase (original tree) from SUZUKI's orchard at Mikkabi, Lot No. 176 of 1925 (Table 185).

Fig. 4. Owari (SUZUKI's original bud variation tree), Lot No. 177 of 1925 (Table 186).

Fig. 5. Fujii Wase (original tree) from FUJII's orchard at Mikkabi, Lot No. 172 of 1925 (Table 187).

Fig. 6. Same as above, Lot No. 182 of 1926 (Table 188).

PL. XLII.

Fig. 1. Owari (FUJII's original bud variation tree), Lot No. 173 of 1925 (Table 189).

Fig. 2. Same as above, Lot No. 186 of 1926 (Table 190).

Fig. 3. Mikami Wase (original tree) from MIKAMI's orchard at Tachibana, Lot No. 166 of 1925 (Table 191).

Fig. 4. Same as above, Lot No. 180 of 1926 (Table 192).

Fig. 5. Zairai (MIKAMI's original bud variation tree), Lot No. 178 of 1925 (Table 193).

PL. XLIII.

Fig. 1. Morita Wase (original tree) from H. MORITA's orchard at Mikkabi, Lot No. 198 of 1926 (Table 194).

Fig. 2. Ikeda (MORITA's original bud variation tree), Lot No. 192 of 1926 (Table 195).

Fig. 3. Sato Wase (original tree) from U. SATO's orchard at Mikkabi, Lot No. 159 of 1925 (Table 196).

Fig. 4. Same as above, Lot No. 188 of 1926 (Table 197).

Fig. 5. Owari (SATO's original bud variation tree), Lot No. 189 of 1926 (Table 198).

PL. XLIV.

Fig. 1. Okamoto Wase (original tree) from OKAMOTO's orchard at Iwashijima, Lot No. 193 of 1926 (Table 199).



Fig. 2. Owari (OKAMOTO's original bud variation tree), Lot No. 194 of 1926 (Table 200).

Fig. 3. Osugi Wase (original tree) from ÔSUGI's orchard at Tsukumi, Lot No. 195 of 1926 (Table 201).

PL. XLV.

Fig. 1. Zairai (ÔSUGI's original bud variation tree), Lot No. 196 of 1926 (Table 202).

Fig. 2. Ichikawa Wase (second generation population) from ICHIKAWA's orchard at Okitsu, Lot No. 193 of 1926 (Table 203).

Fig. 3. Ueno Wase (second generation) from KUBO's orchard at Ryûmon, Lot No. 201 of 1926 (Table 204).

Fig. 4. Ikeda from the same orchard, Lot No. 200 of 1926 (Table 205).

Fig. 5. Kubo Wase (original tree) from the same orchard, Lot No. 185 of 1926 (Table 206).

PL. XLVI.

Fig. 1. Matsuki Wase (original tree) from MATSUKI's orchard at Mariko, Lot No. 44 of 1920 (Table 207).

Fig. 2. Owari (MATSUKI's original bud variation tree), fruits just below the swelling, Lot No. 43 of 1920 (Table 208).

Fig. 3. The same, fruits from normal part down below, Lot No. 42 of 1920 (Table 209).

Fig. 4. Yamamoto Hiramî Satsuma (original tree) from YAMAMOTO's orchard at Hayakawa, Lot No. 98 of 1923 (Table 210).

Fig. 5. Same as above, Lot No. 133 of 1924 (Table 211).

PL. XLVII.

Fig. 1. Owari (YAMAMOTO's original bud variation tree), Lot No. 99 of 1923 (Table 212).

Fig. 2. Tsuda's Hiramî Satsuma (second generation), first pick, from TSUDA's orchard at Kawamura, Lot No. 118 of 1924 (Table 213, *pro parte*).

Fig. 3. Same as above, second pick, Lot No. 152 of 1924 (Table 213, *pro parte*).

Fig. 4. Owari, a part from TSUDA's Hiramî Satsuma tree, Lot No. 154 of 1924 (Table 214).

Fig. 5. Owari from KUBO's orchard at Ryûmon, Lot No. 202 of 1926.

PL. XLVIII.

(Up to PL. LII, sketches of trees, requiring critical observation)

Fig. 1. MATSUO's Sase Nakashima individual in 1923, viewed from north.

Fig. 2. KAGAYAMA's Hira (original tree) in 1919.

Fig. 3. KAWANO's Zairai, the largest Satsuma tree ever recorded, viewed from N-W, in 1920.

Fig. 4. T. YAKUSHIJÛ's Owari, the oldest at Tachima, studied in 1920.

Fig. 4a. Same as above, viewed from above, showing 5 main trunks.

Fig. 5. YABUNE's variegated Ikeda, (top-worked at t) studied in 1920. s. self-colored (green) branchlets mixed in with variegated limbs (v).

Fig. 6. Variegated Ikeda A at Arita Station, showing distribution of self-colored (green) branchlets, s. (v. variegated).

Fig. 7. Variegated Ikeda B at Arita Station with variegated limb, a.

Fig. 7a. Same as above, enlarged. s. green, v. variegated limbs.

Fig. 8. YABUNE's one more variegated Ikeda.

Fig. 9. M. GORYÔDA's Willow-leaf Ikeda; left normal, right willow.

Fig. 10. NABEKAWA's bud variation Willow-leaf Ikeda. n. normal, w. willow branches.

- Fig. 11. NARIKAWA's second tree (two plants set together), partly normal and partly willow, originally two separate individuals.  
 Fig. 12. BASSET's Willow-leaf Ikeda in Alabama.  
 Fig. 13. Kawano Wase (original tree 2), sketched in 1920 from west.  
 Fig. 14. Kawano Wase (original tree 1), sketched in 1924.  
 Fig. 15. Kawano Wase (original tree 2), sketched in 1924 from east.

## PL. XLIX.

- Fig. 1. Kawano Wase (original tree 3), sketched in 1924. Top-worked at t.  
 Fig. 2. Kawano Wase (original tree 4), sketched in 1924.  
 Fig. 3. Owari at the north side of original Kawano Wase tree 2, sketched in 1924.  
 Fig. 4. Yakushiji Wase (original tree), sketched in 1919.  
 Fig. 5. Same as above, sketched in 1926.  
 Fig. 6. Kawano Wase from HATSUMOTO's orchard at Ôchô, showing fruits borne on adventitious bud on Wase trunk (w) which later sends forth an Owari (r) branch.  
 Fig. 7. Reverting Kawano Wase 1 from MAMYÔ's orchard at Ôchô, with reverted branch (r), viewed from the path.  
 Fig. 8. The same tree viewed from N-W, with (r) branch at the left.  
 Fig. 8a. The bottom of the same, showing graft union.  
 Fig. 9. Reverting Kawano Wase tree 2 from the same orchard, viewed from the path.  
 Fig. 10. The same tree viewed from N-W, with (r) branch at the centre.  
 Fig. 10a. The same, reverting point enlarged with scar marking.  
 Fig. 11. Reverting Kawano Wase from ÔMURA's orchard at Tsukumi, with reverting branch (r). (o), originally Owari, being double-budded.  
 Fig. 12. Reverting tree 1 from KAWANO's 2 generation Wase, with reverting branch (r)  
 Fig. 13. Reverting tree 2 from the same orchard.  
 Fig. 14. Reverting tree 23 from HATSUMOTO's orchard at Ôchô  
 Fig. 15. Reverting tree 24 from the same orchard.  
 Fig. 16. Reverting tree 25 from the same orchard.  
 Fig. 17. Reverting tree 33 from the same orchard.  
 Fig. 18. Reverting tree 49 from the same orchard.  
 Fig. 19. Reverting tree 68 from the same orchard.  
 Fig. 20. Reverting tree 79 from the same orchard.  
 Fig. 21. Reverting tree 85 from the same orchard.  
 Fig. 22. Reverting tree 87 from the same orchard.

## PL. L.

- Fig. 1. Reverting tree 4 from ÔNO's orchard at Ôchô.  
 Fig. 2. Reverting tree 5 from the same orchard.  
 Fig. 3. Reverting tree 7 from the same orchard.  
 Fig. 4. Reverting tree 8 from the same orchard.  
 Fig. 5. Reverting tree 14 from the same orchard.  
 Fig. 6. Reverting tree 16 from the same orchard.  
 Fig. 7. Reverting tree 18 from the same orchard.  
 Fig. 8. Reverting tree 24 from the same orchard.  
 Fig. 9. Reverting tree 33 from the same orchard.  
 Fig. 10. Reverting tree 37 from the same orchard.  
 Fig. 11. Reverting tree 42 from the same orchard.  
 Fig. 12. Reverting tree 44 from the same orchard.  
 Fig. 13. Reverting tree 48 from the same orchard.

- Fig. 14. Reverting tree 51 from the same orchard.
- Fig. 15. Reverting tree 53 from the same orchard.
- Fig. 16. Reverting tree 57 from the same orchard.
- Fig. 17. Reverting tree 64 from the same orchard.
- Fig. 18. Reverting tree 66 from the same orchard.
- Fig. 18a. The same, top of the branch showing reverted part.
- Fig. 19. Reverting tree 67 from the same orchard.
- Fig. 20. Reverting tree 74 from the same orchard.
- Fig. 21. Reverting tree 76 from the same orchard.
- Fig. 22. Reverting tree 94 from the same orchard.
- Fig. 23. Reverting tree 99 from the same orchard.
- Fig. 24. Reverting tree 116 from the same orchard, viewed from NWW.
- Fig. 24a. The same, viewed from south.
- Fig. 24b. The same, view of the centre of the tree, seen on approach.
- Fig. 25. Reverting tree 40 from ASAUMI's orchard at Ōchō.
- Fig. 25a. The same, view of the centre of the tree, seen on approach.
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## PL. LL.

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- Fig. 2. Higuchi Wase (second generation tree) from the same orchard.
- Fig. 3. Hozaki Wase (original tree), sketched in 1920.
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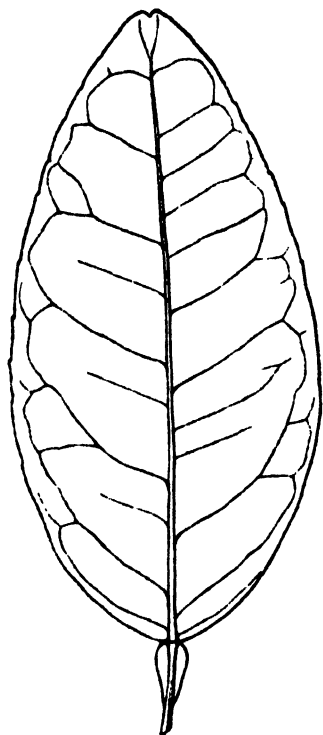


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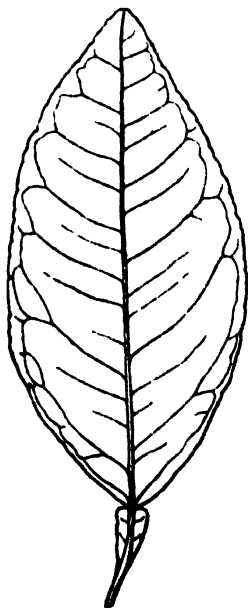


Fig. 4

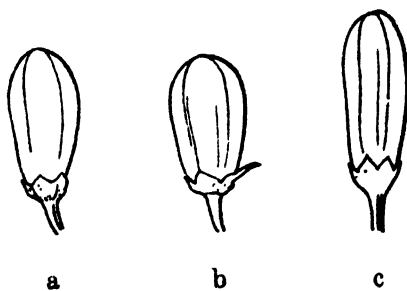


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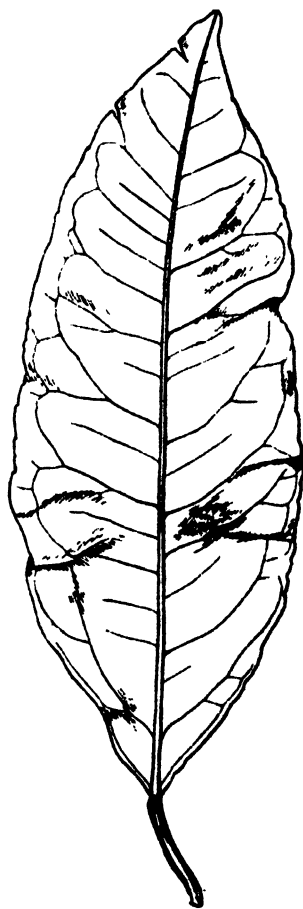




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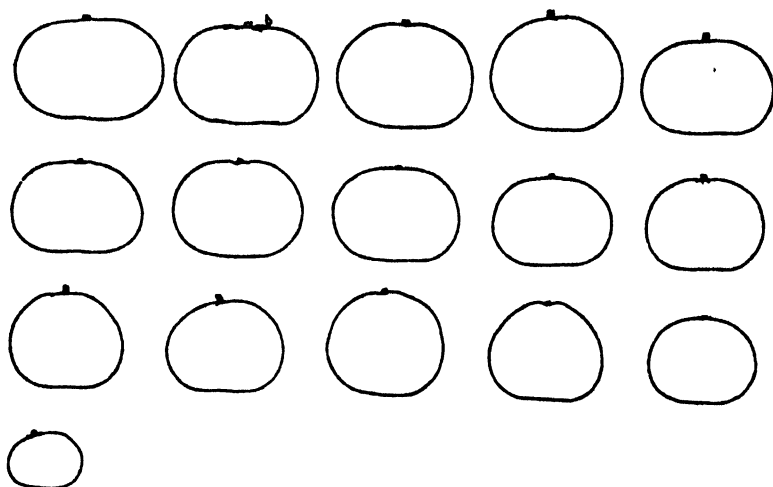


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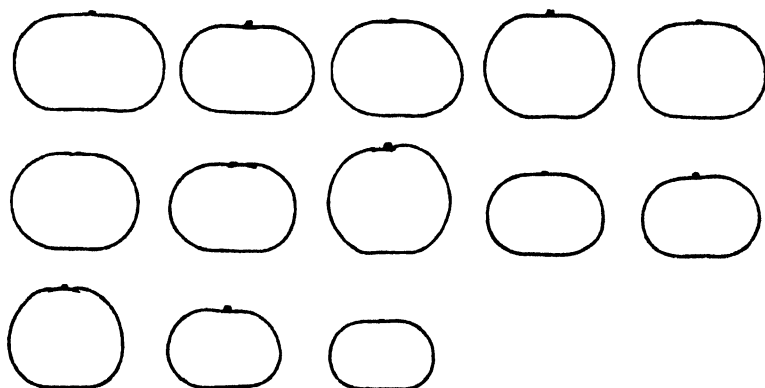


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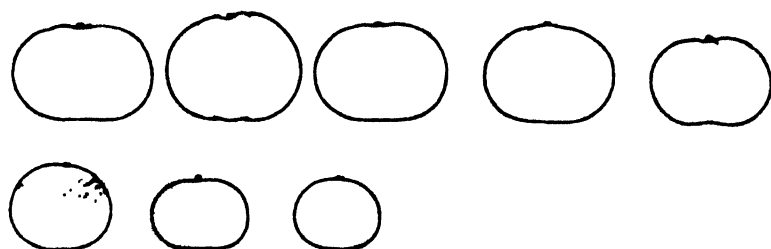
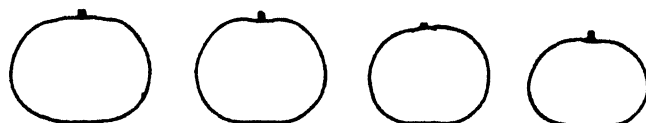


Fig. 4



PL.III.

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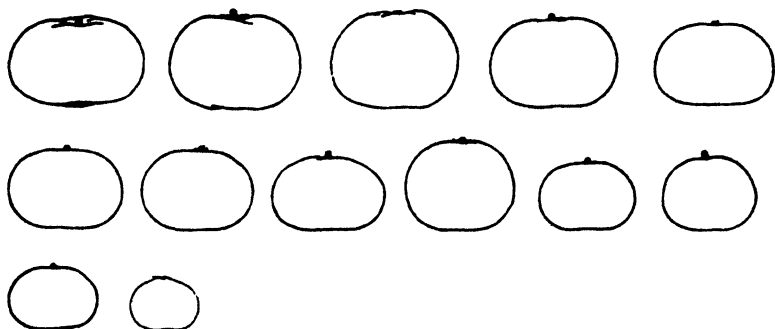


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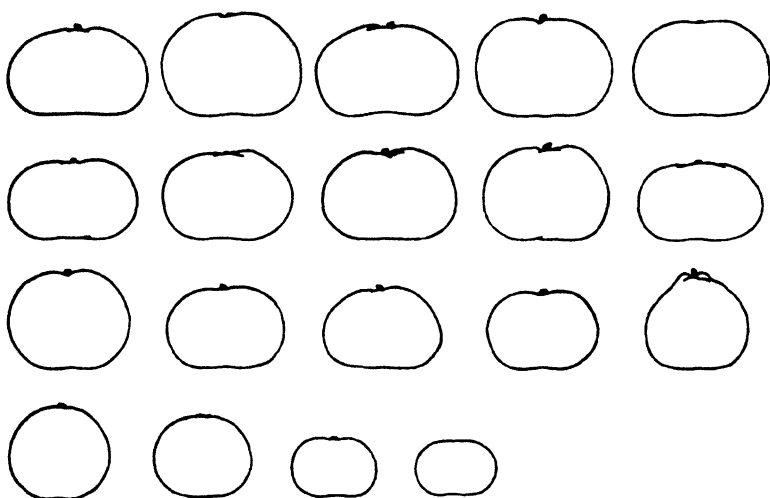


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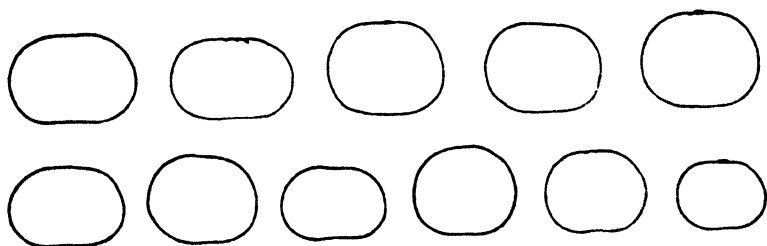
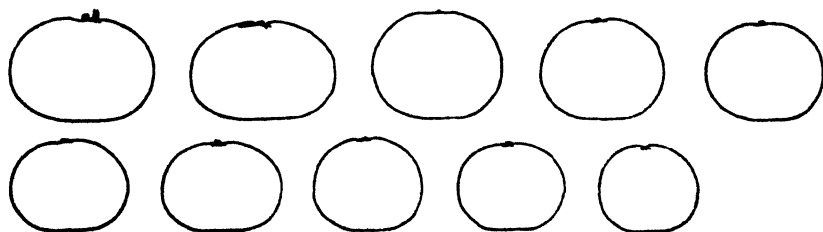


Fig. 4



PL. IV.

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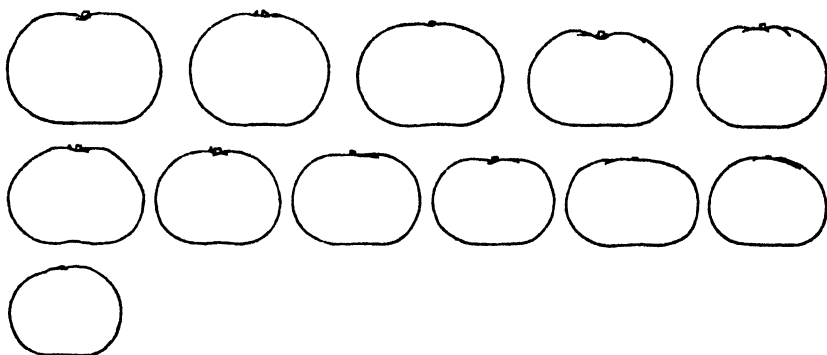


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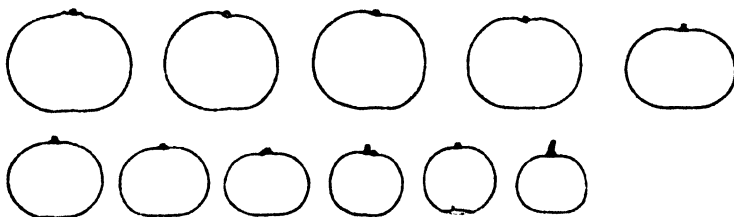


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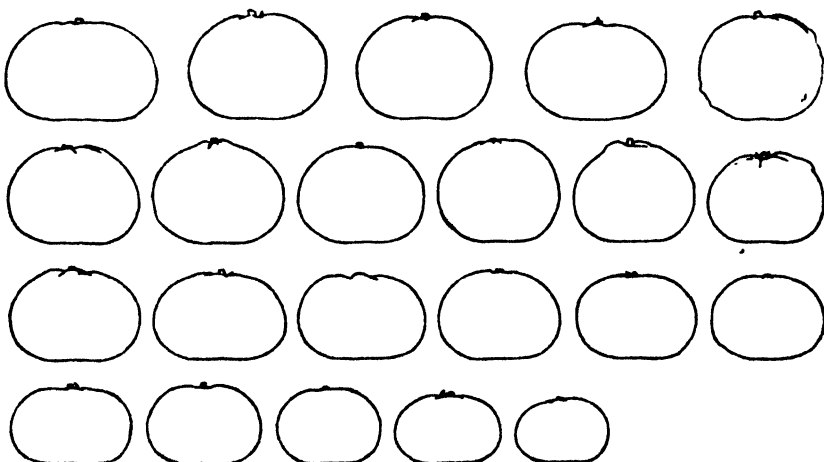


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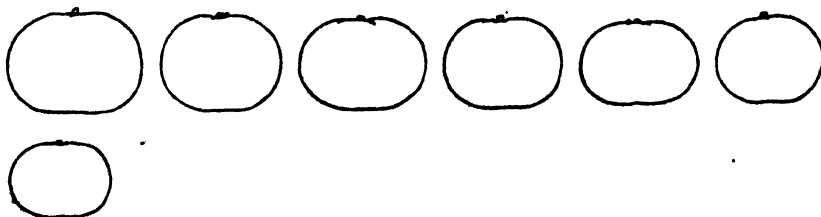


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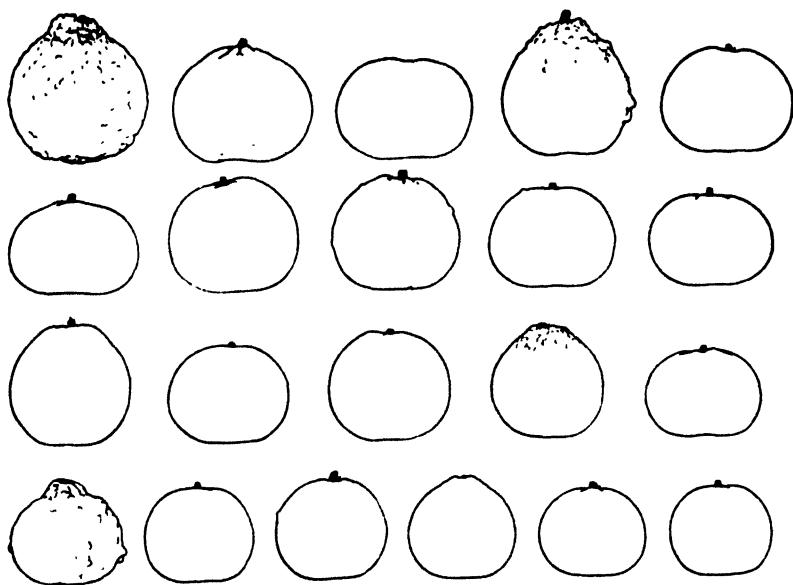


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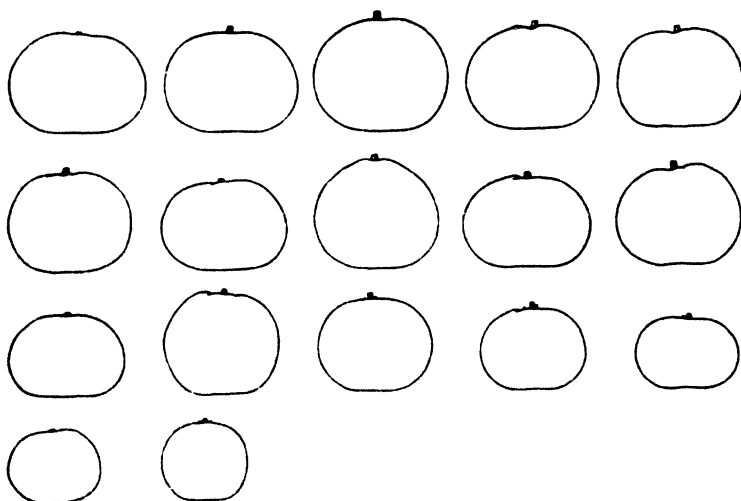


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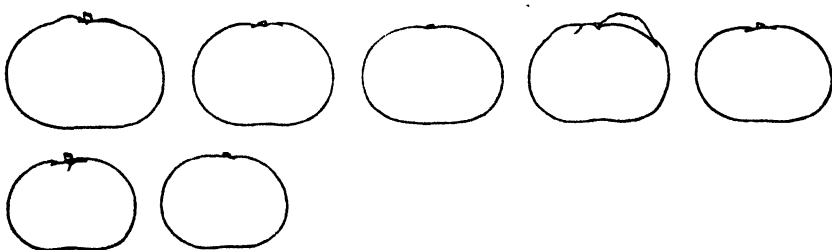


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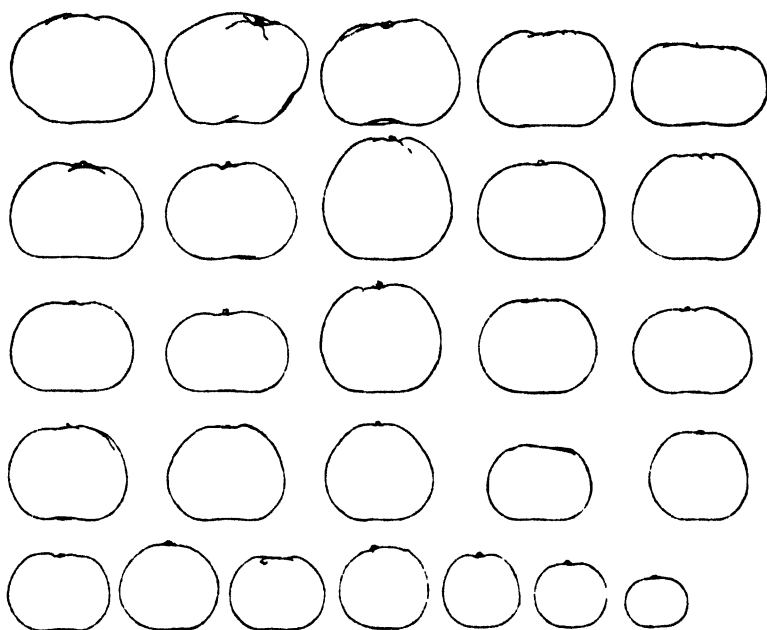


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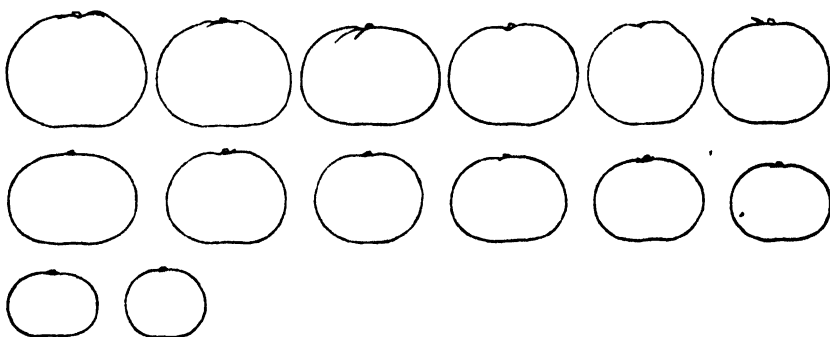


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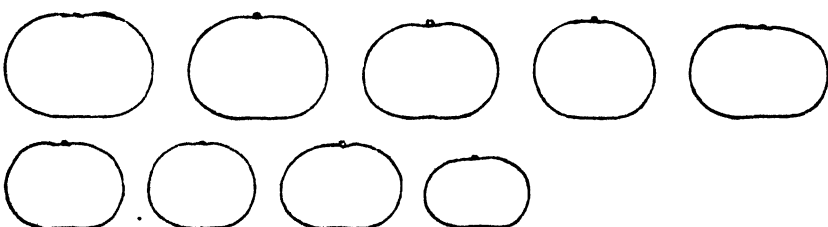


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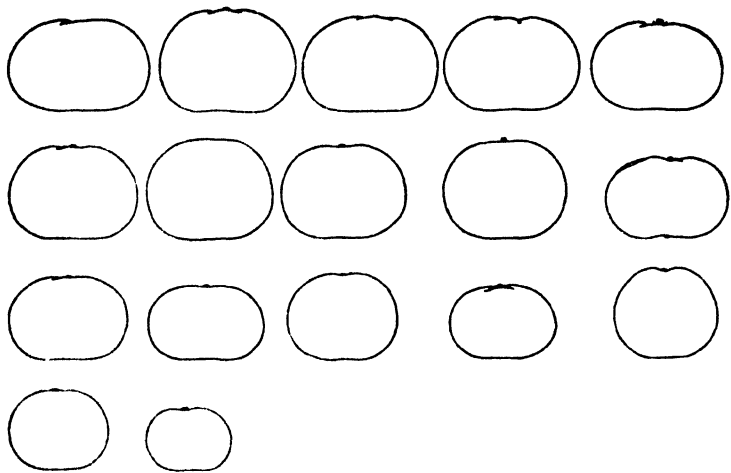
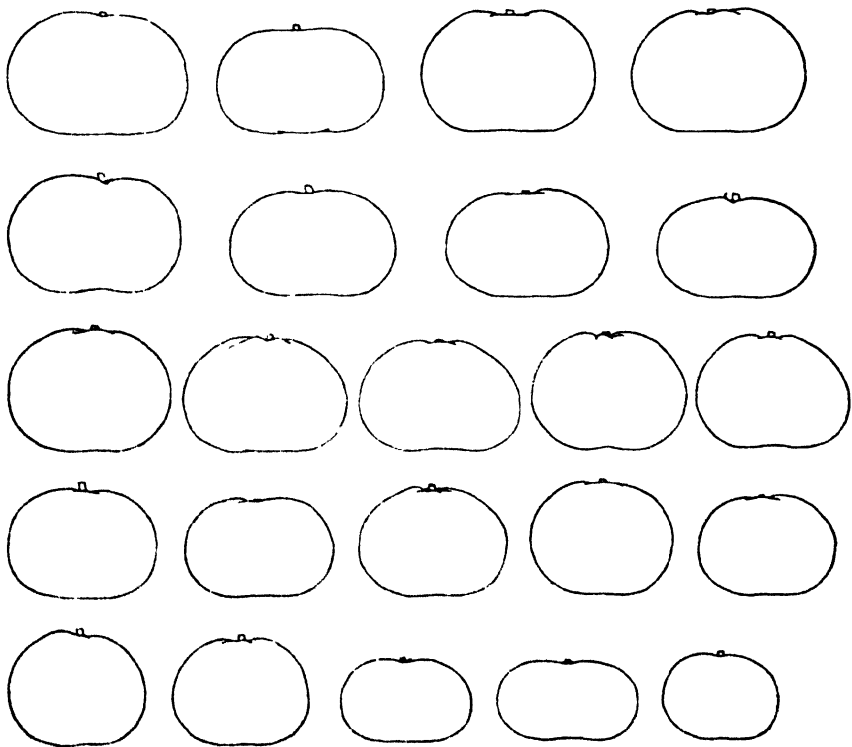


Fig. 2



PL. VIII.

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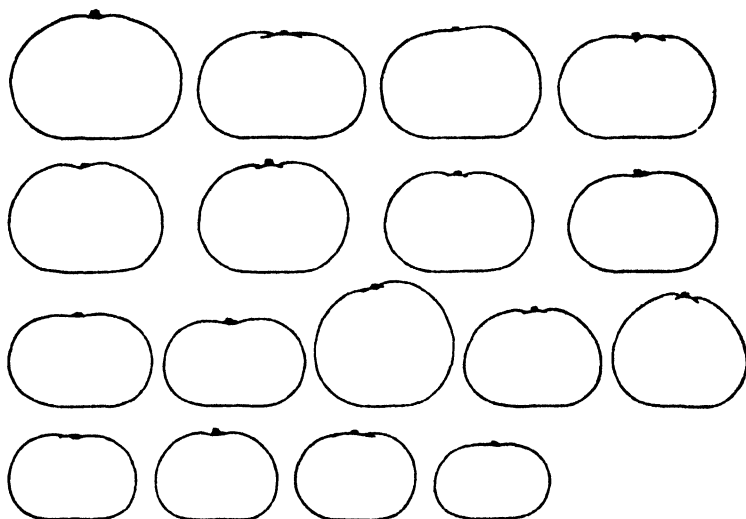


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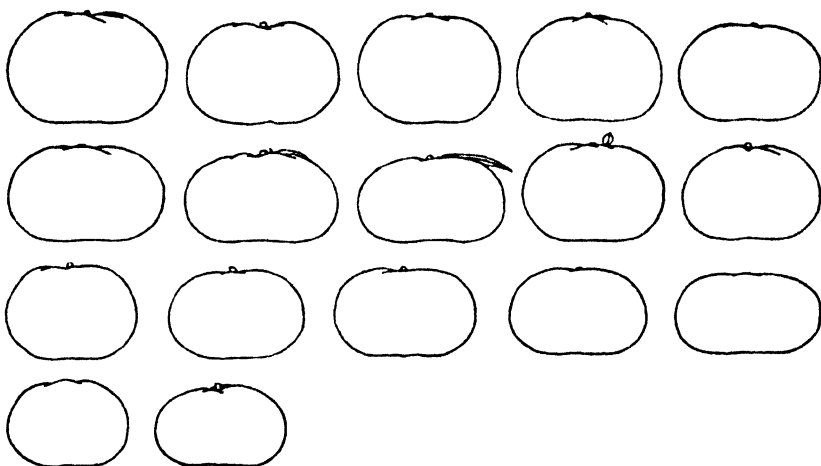
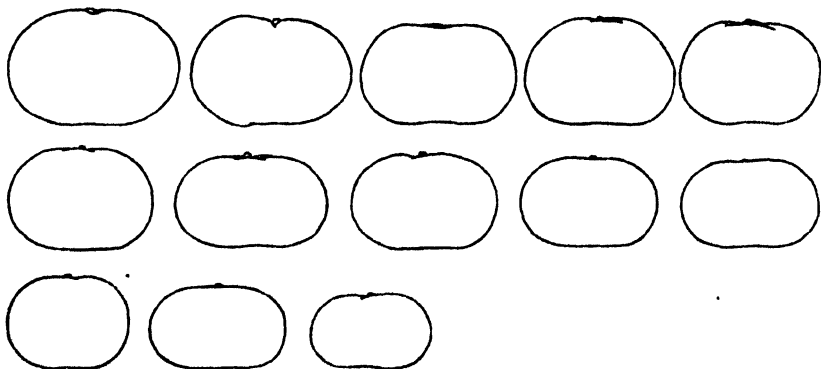


Fig. 3



PL. IX.

Fig. 1

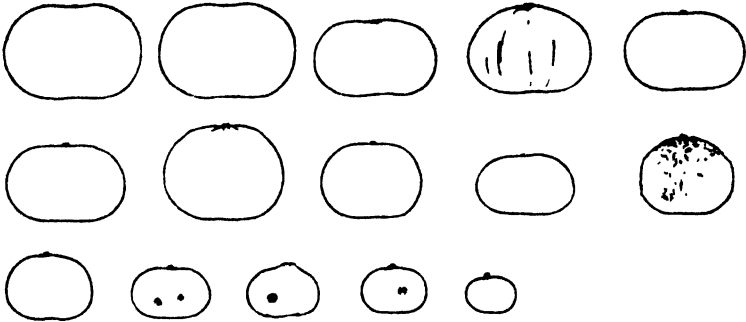


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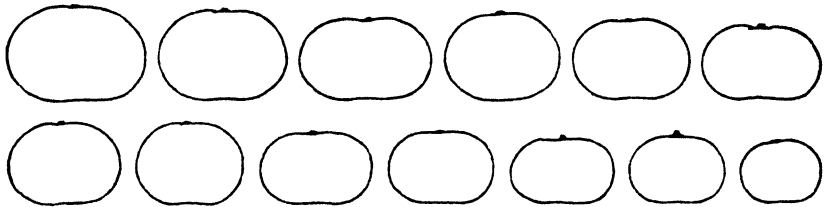
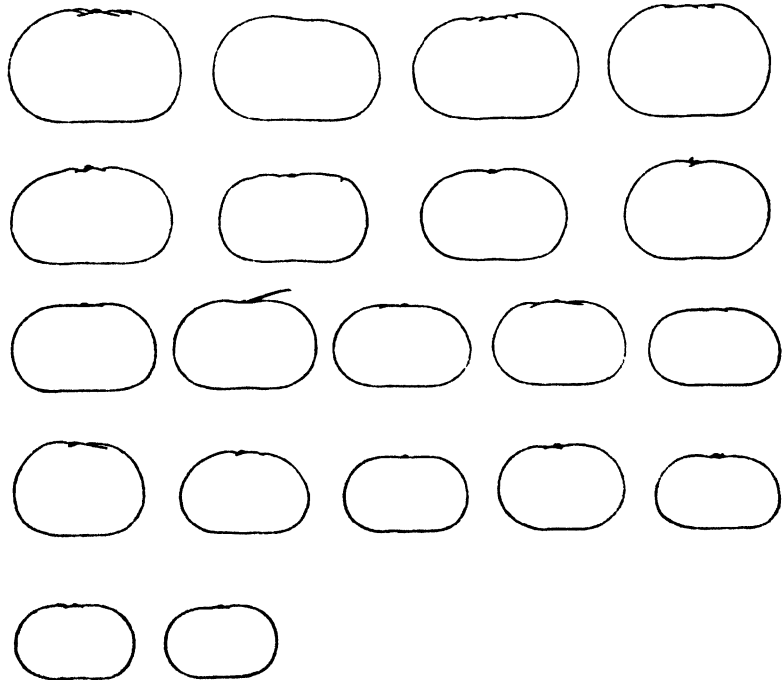


Fig. 3



Fig. 4





PL. X.

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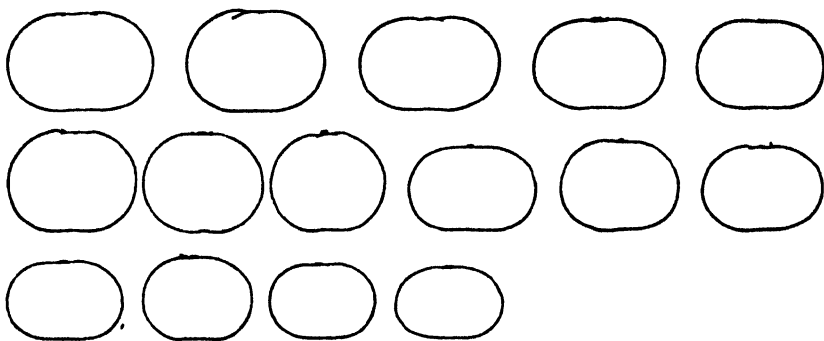


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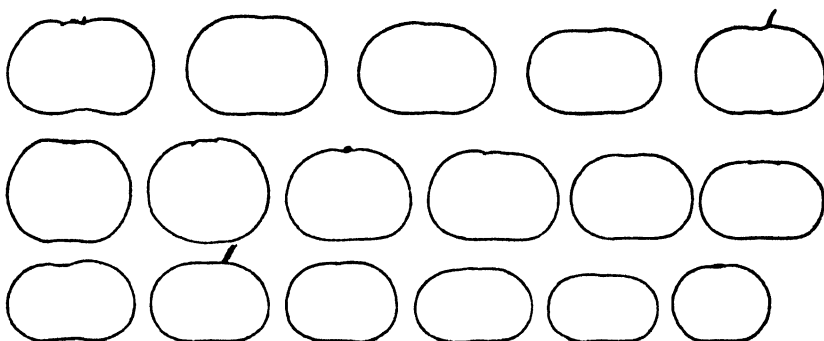


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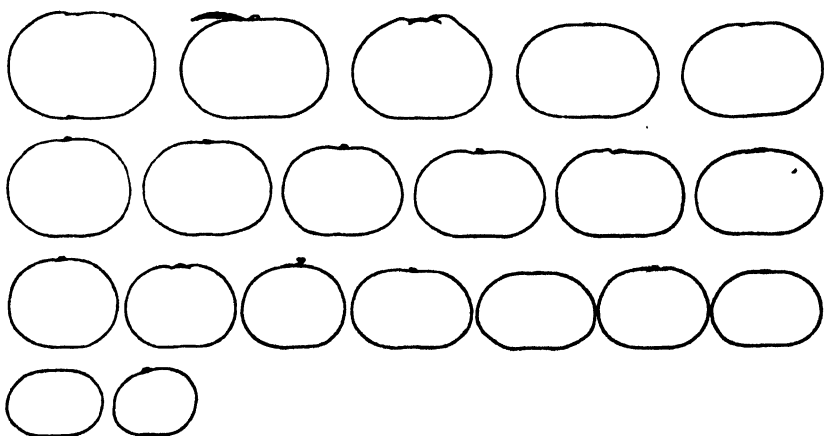


Fig. 4



Fig. 1

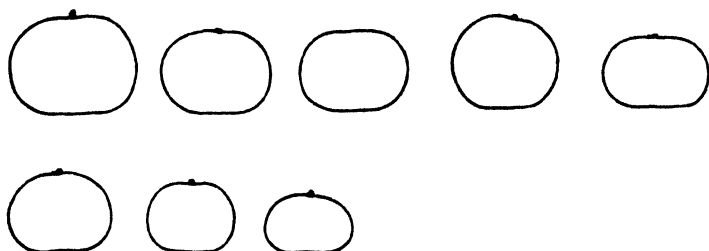


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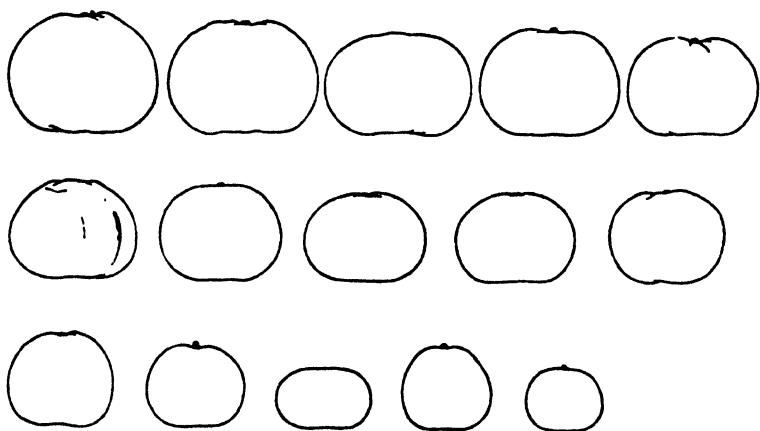


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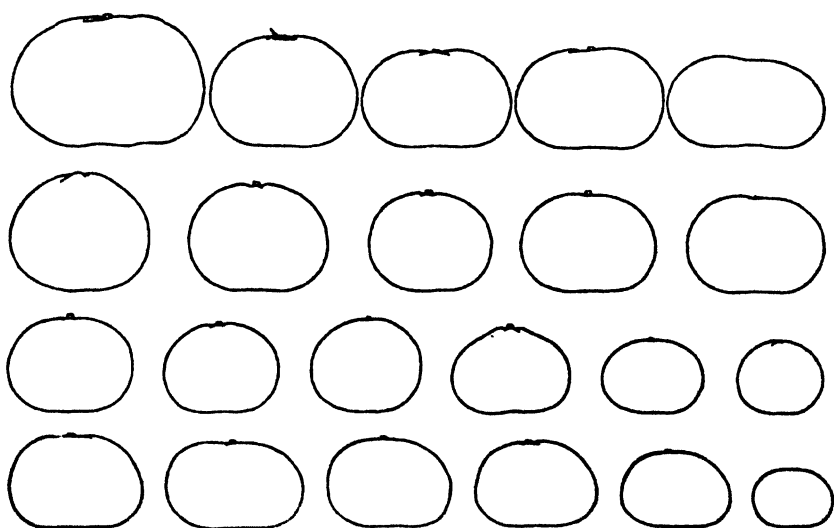


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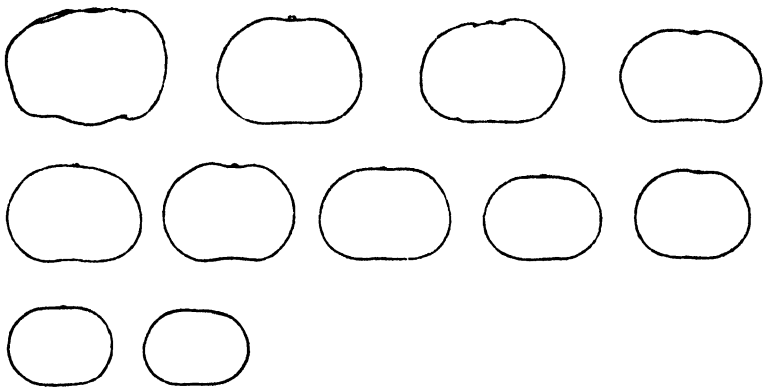


Fig. 2

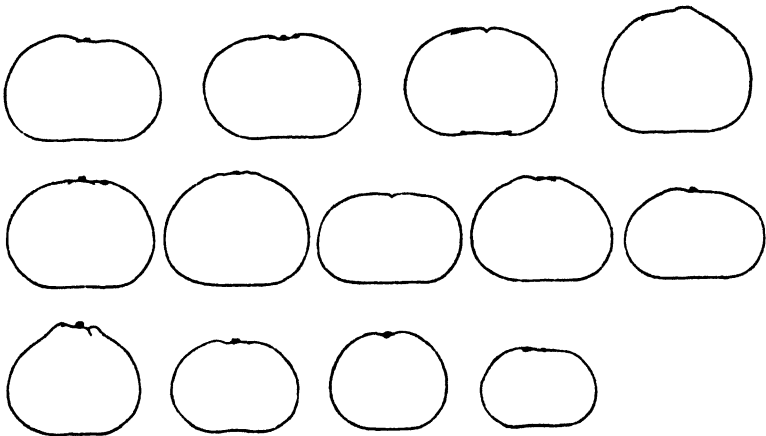
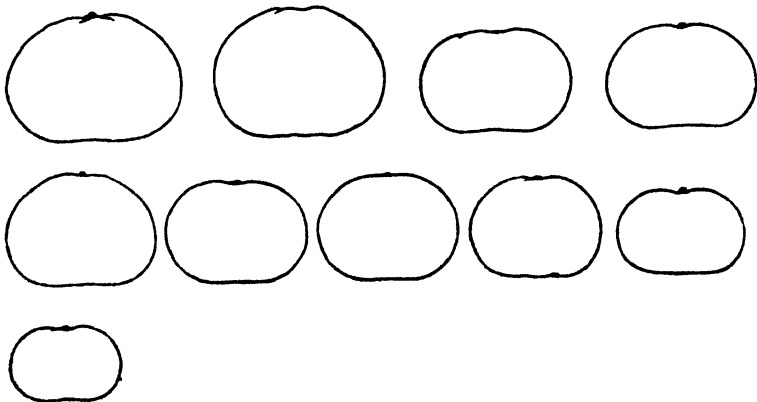
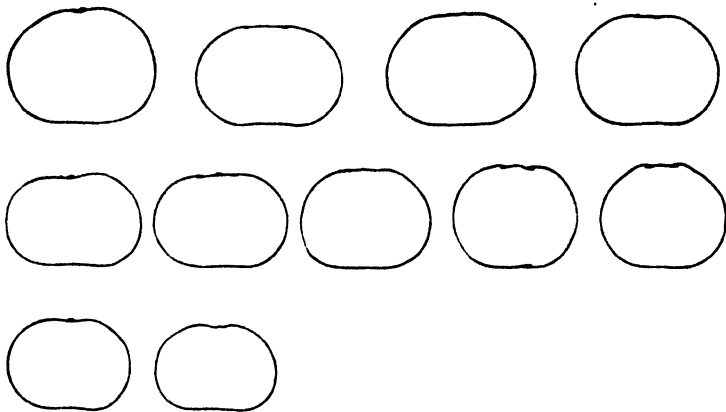


Fig. 3

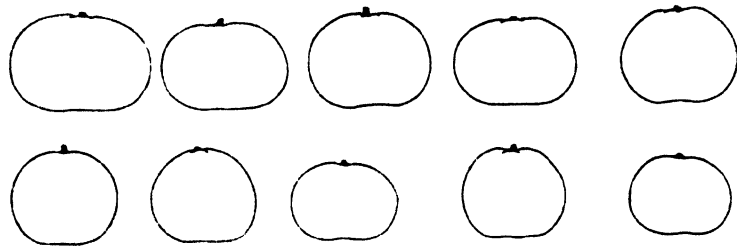


**PL. XIII.**

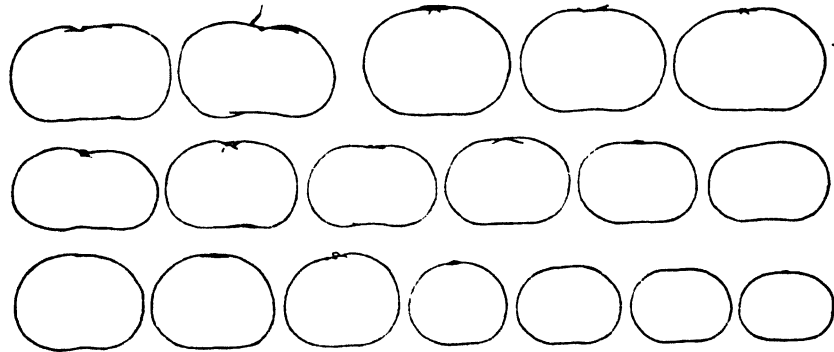
**Fig. 1**



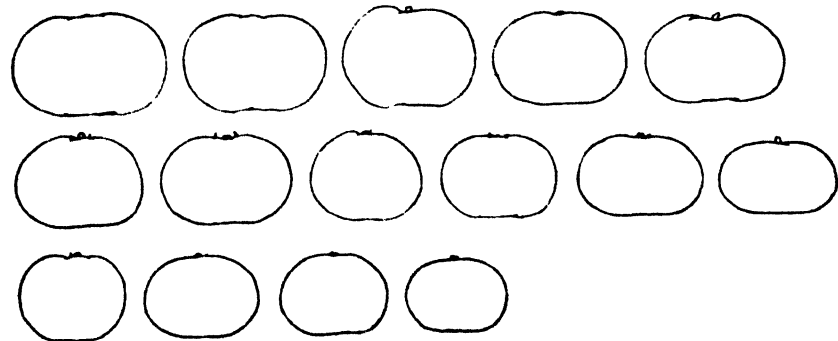
**Fig. 2**



**Fig. 3**



**Fig. 4**



PL. XIV.

Fig. 1

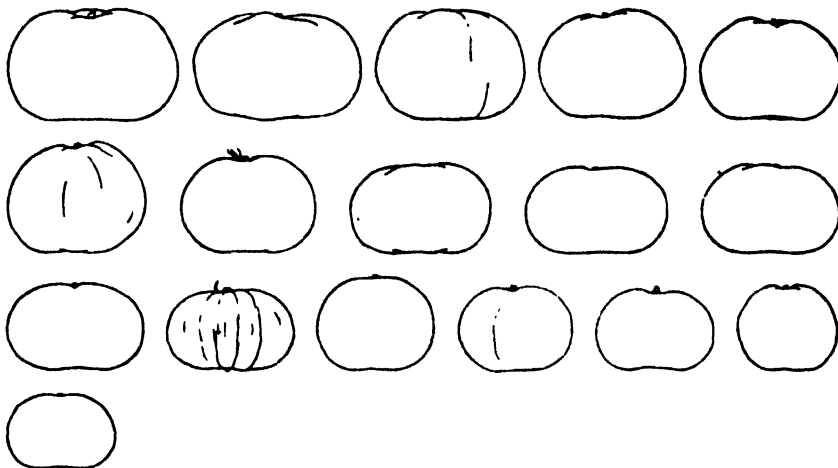


Fig. 2

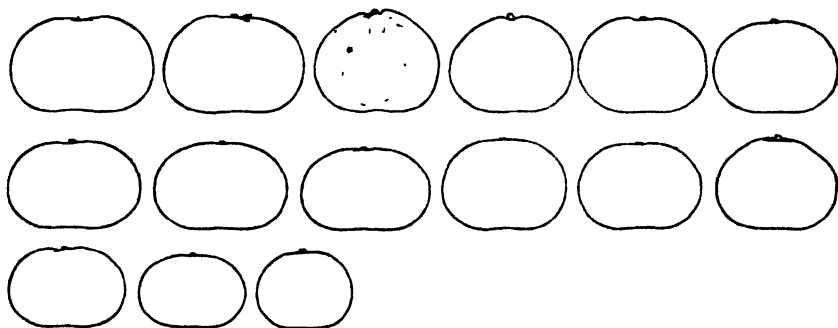


Fig. 3

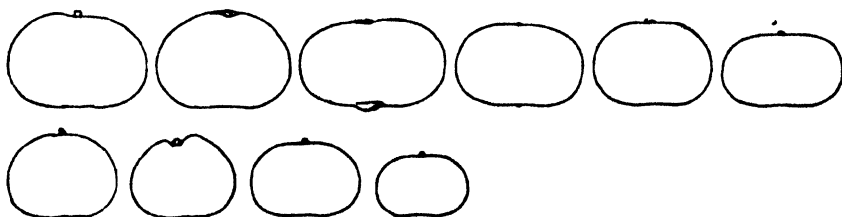
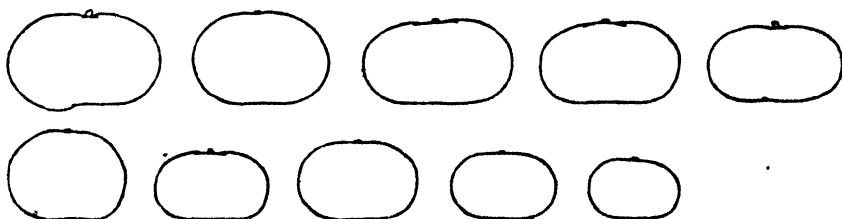


Fig. 4



PL. XV.

Fig. 1



Fig. 2

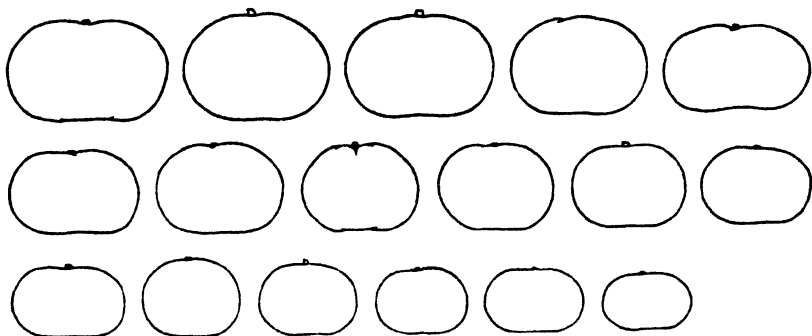


Fig. 3

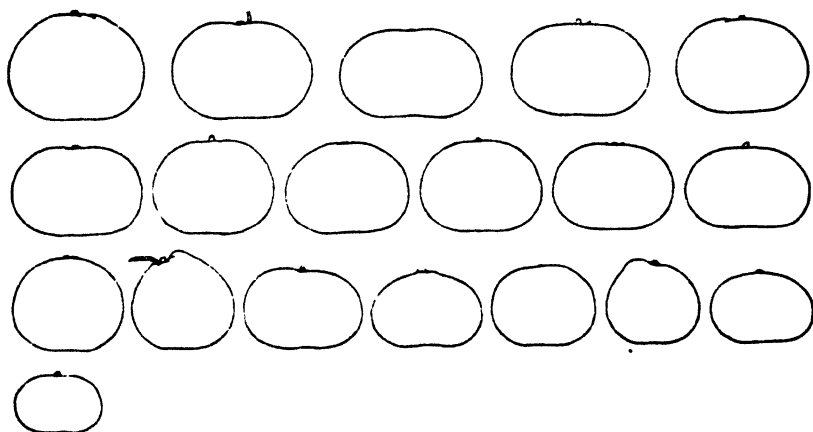
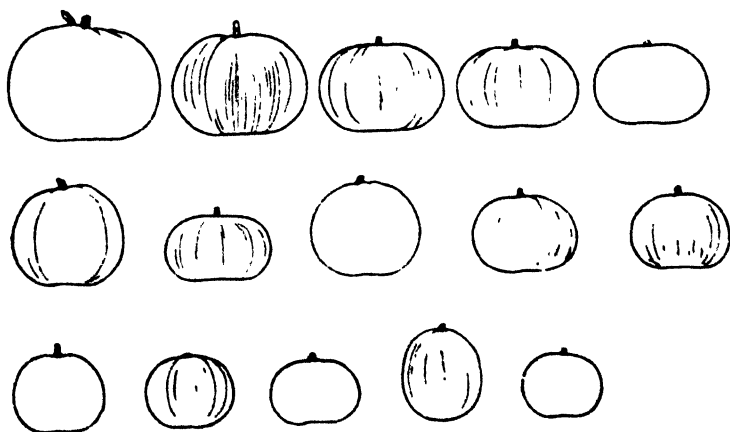


Fig. 4



PL. XVI.

Fig. 1



Fig. 2

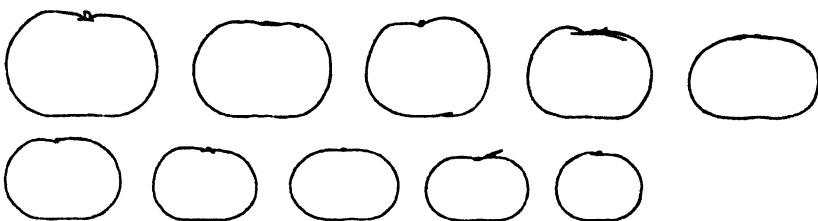


Fig. 3



Fig. 4

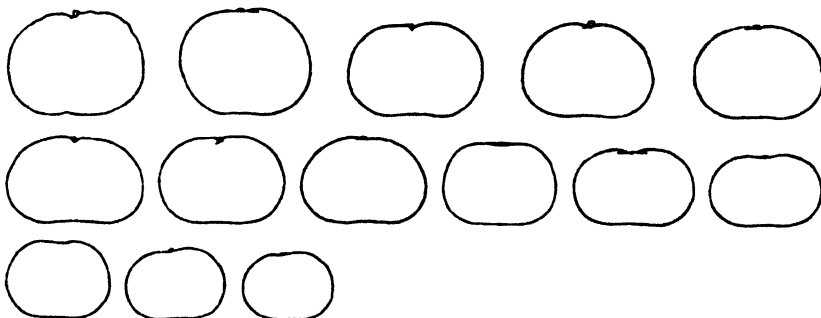


Fig. 5

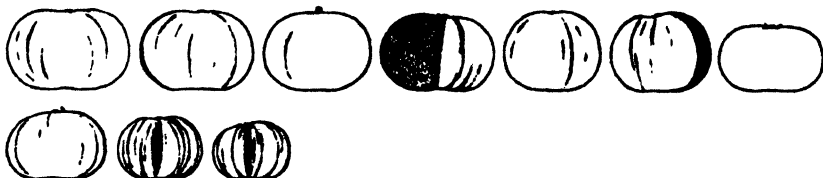
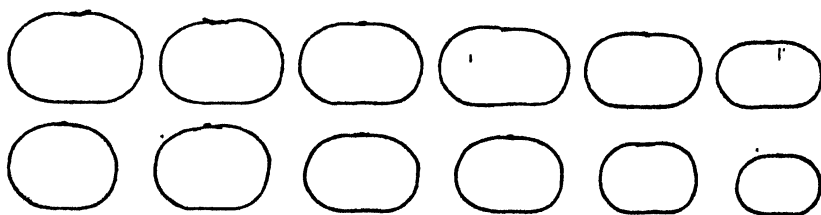


Fig. 6



PLXVII

Fig. 1

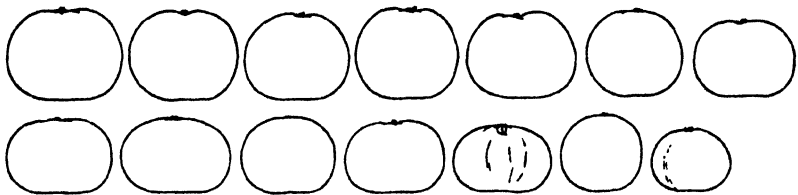


Fig. 2

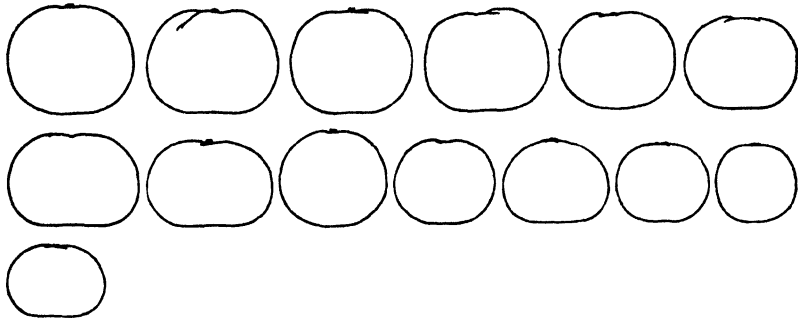


Fig. 3



Fig. 4

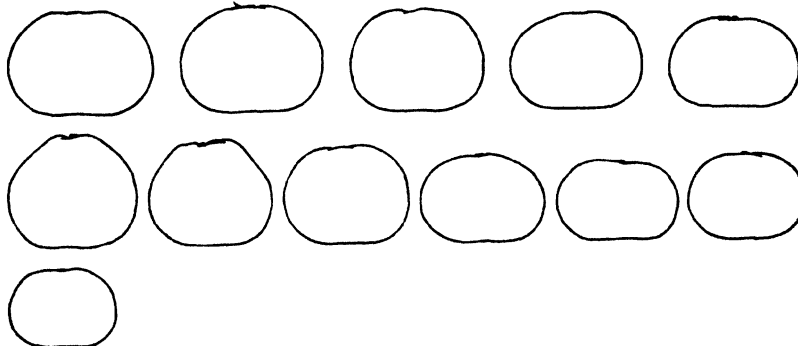
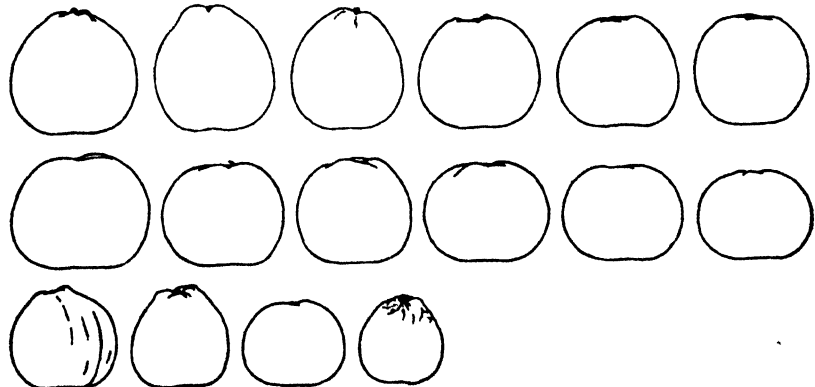


Fig. 5





PL. XVIII.

Fig. 1

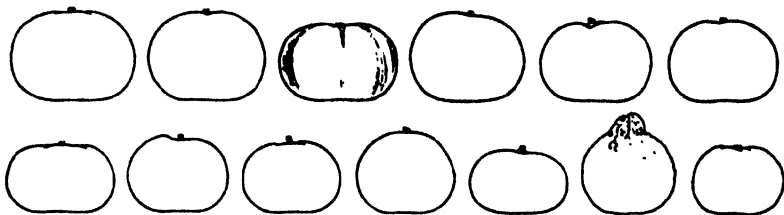


Fig. 2

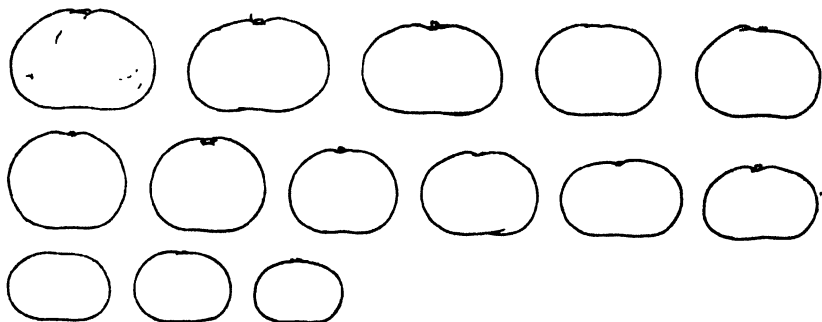


Fig. 3

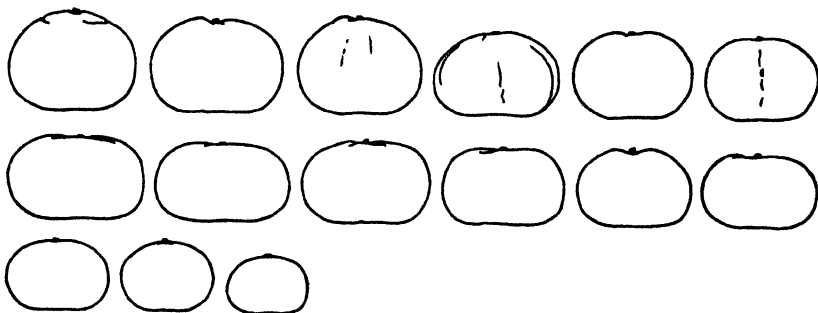


Fig. 4

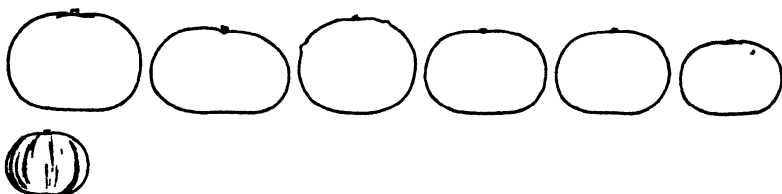


Fig. 5

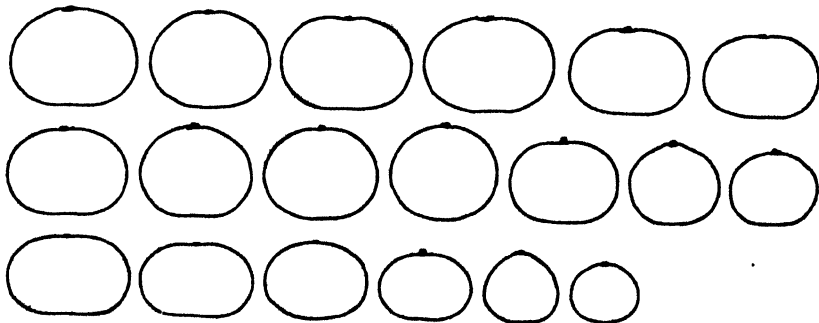


Fig. 1



Fig. 2



Fig. 3

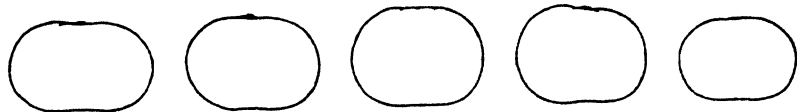


Fig. 4

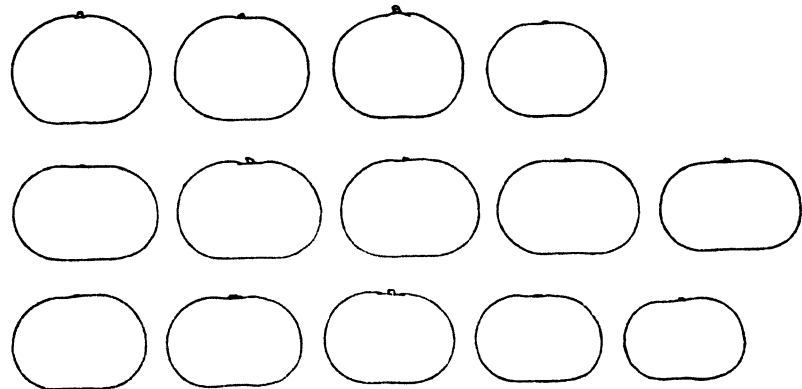


Fig. 5

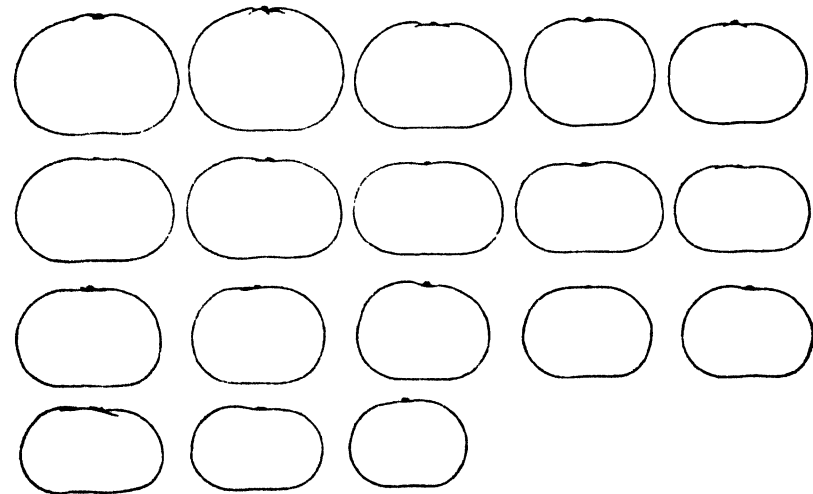


Fig. 1

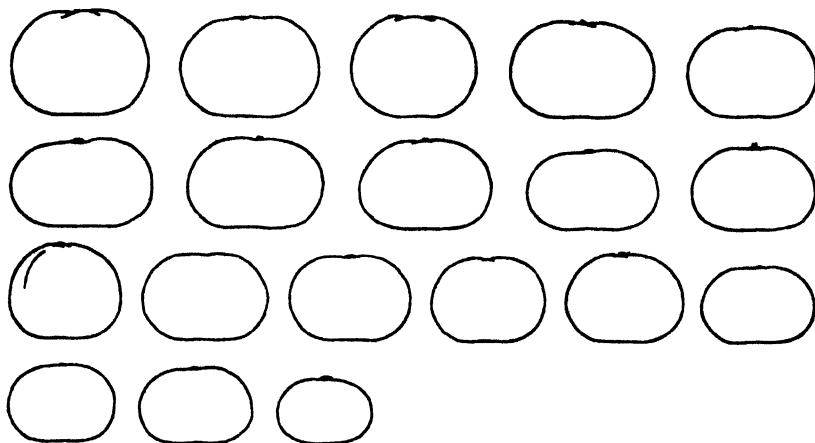


Fig. 2

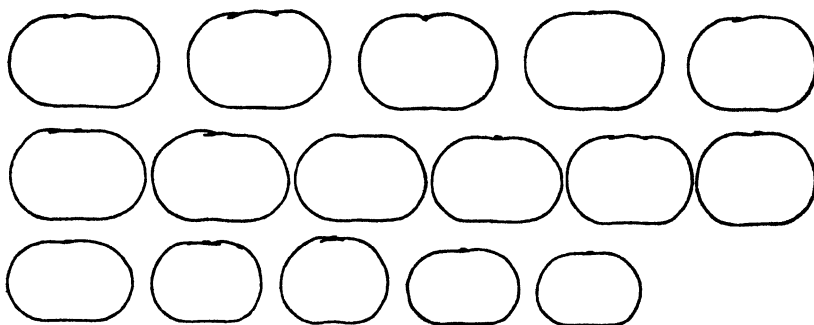


Fig. 3

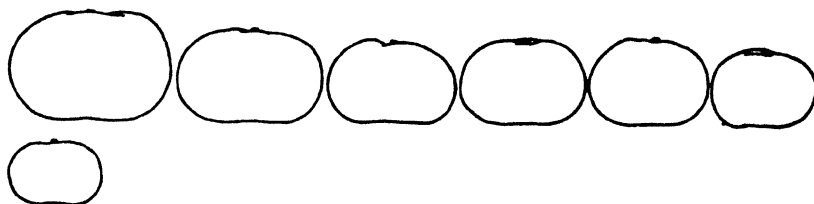


Fig. 4

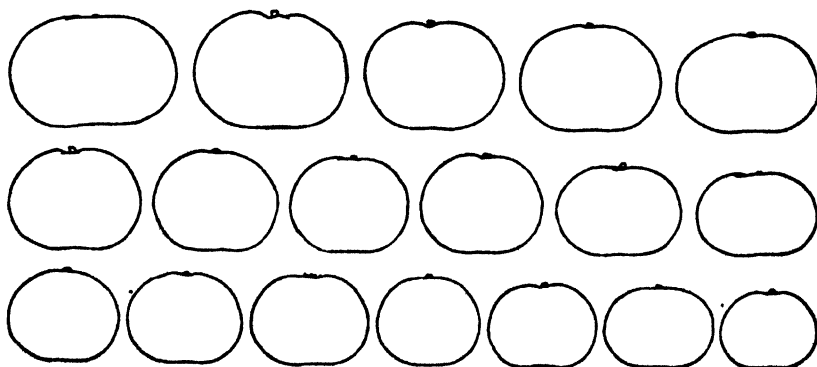


Fig. 1

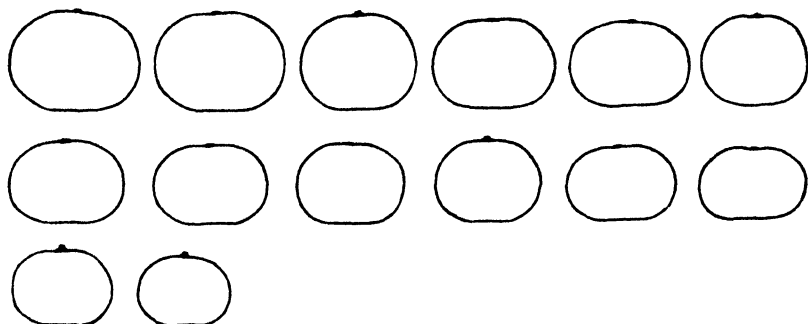


Fig. 2

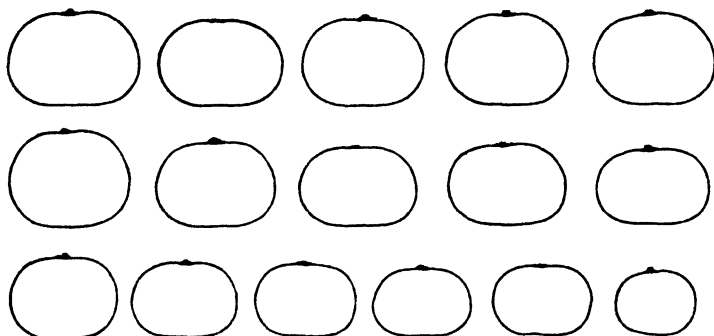


Fig. 3

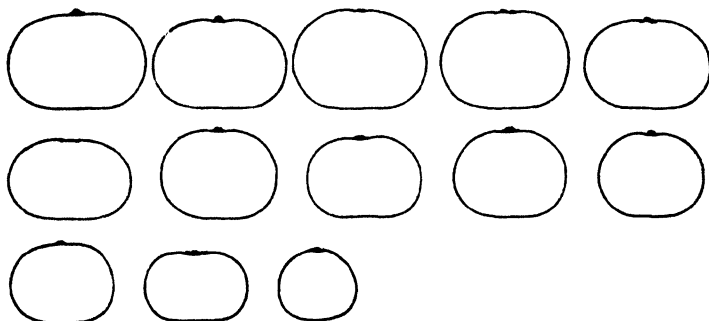


Fig. 4

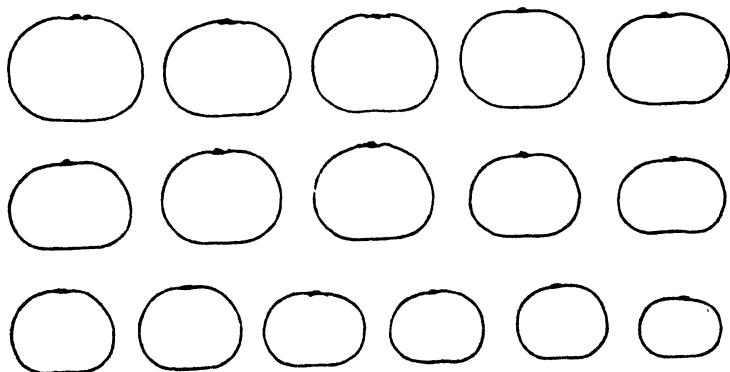


Fig. 1

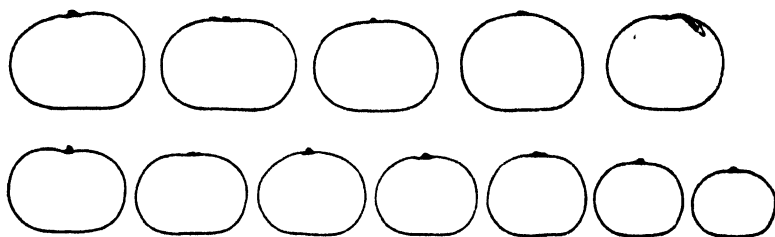


Fig. 2

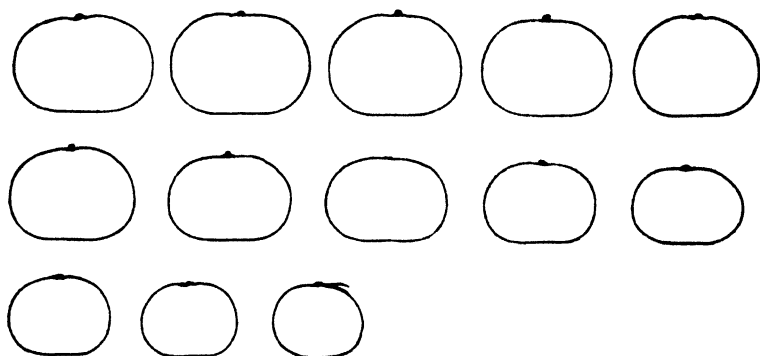


Fig. 3

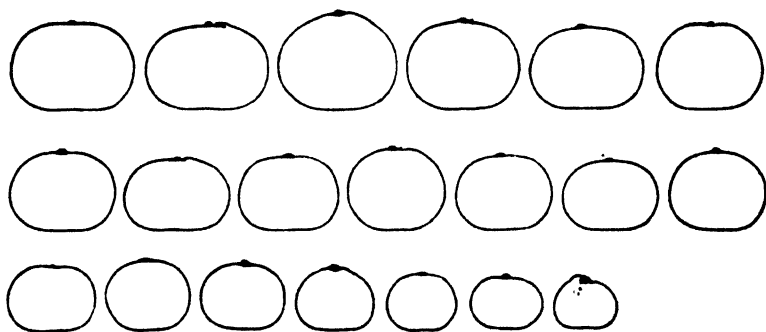
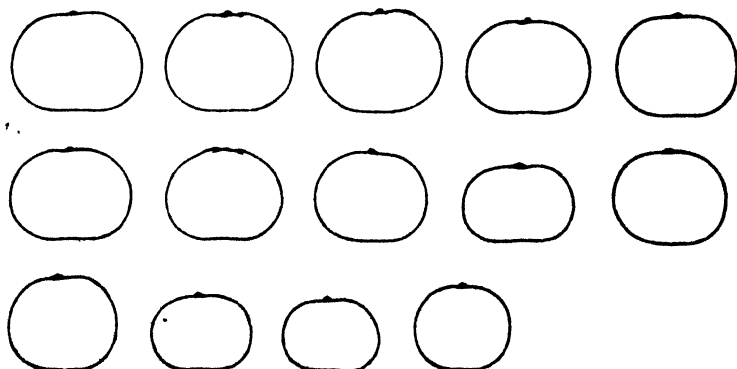


Fig. 4



PL. XXIII.

Fig. 1



Fig. 2

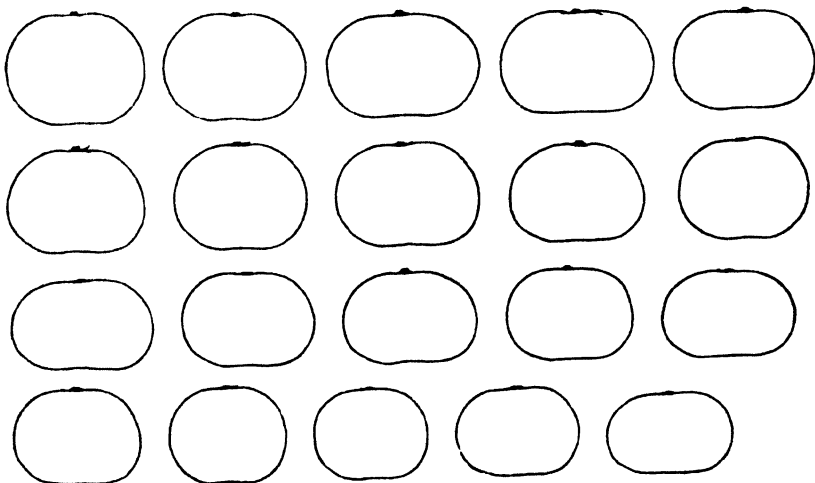


Fig. 3

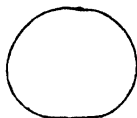


Fig. 4

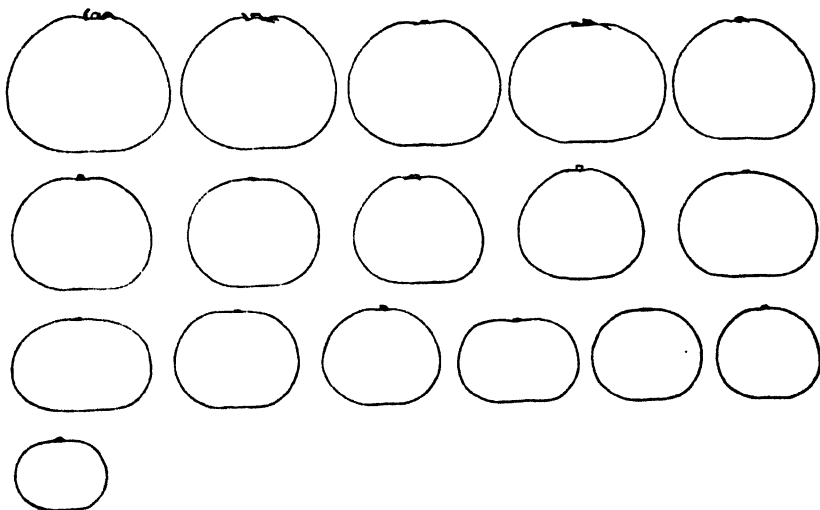


Fig. 5



Fig. 1

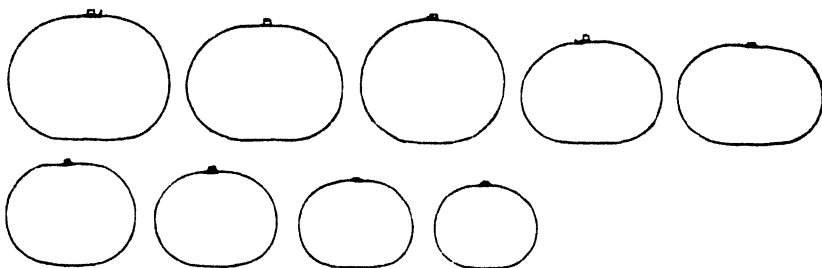


Fig. 2

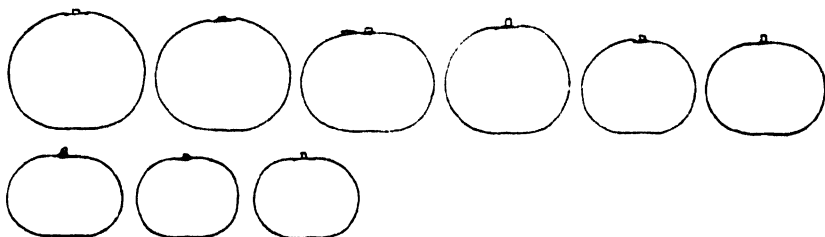


Fig. 3

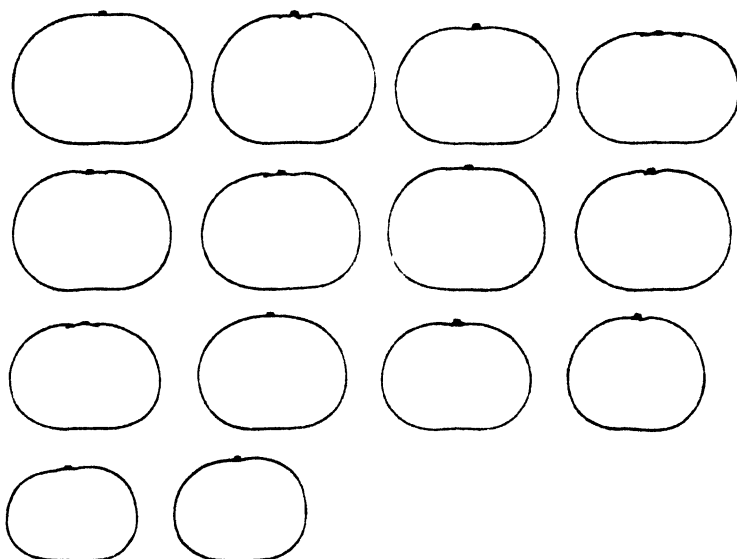


Fig. 4

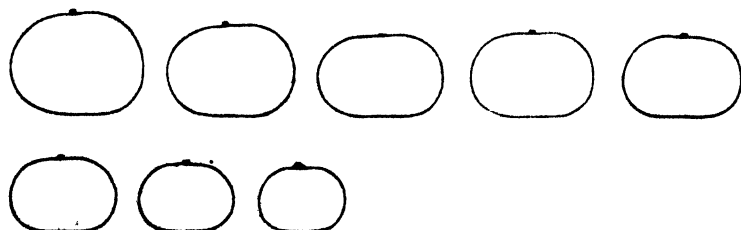


Fig. 1

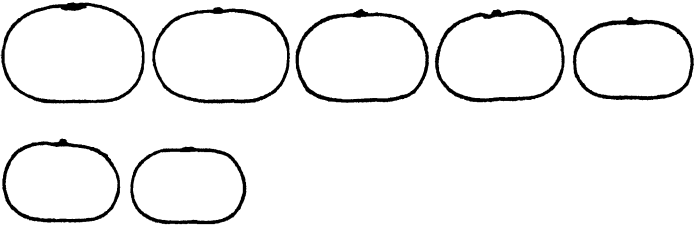


Fig. 2

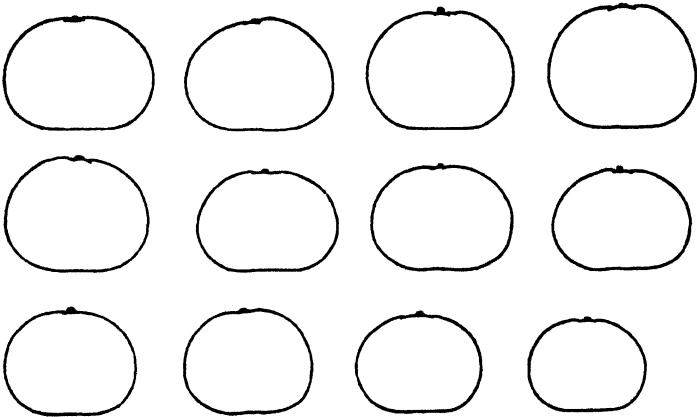


Fig. 3

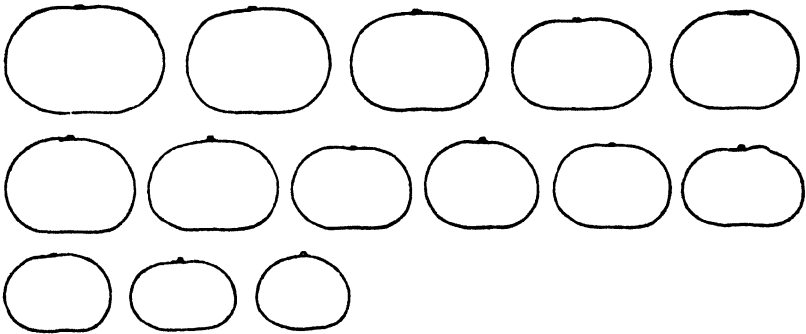


Fig. 4

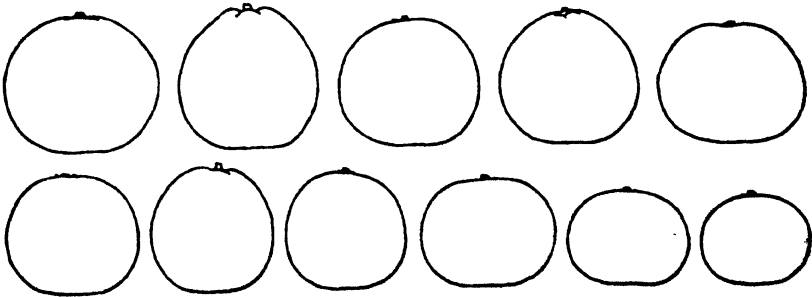




Fig. 1

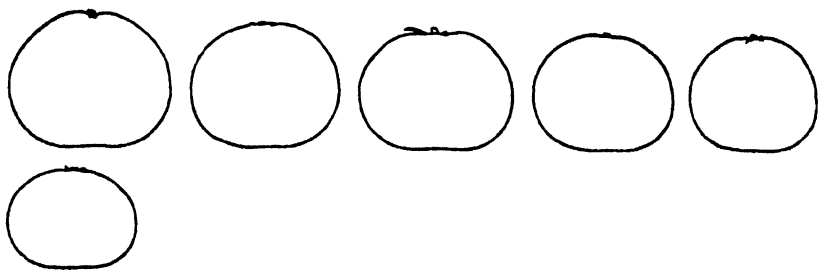


Fig. 2

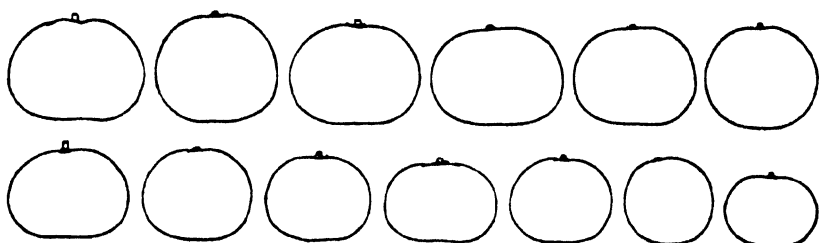


Fig. 3

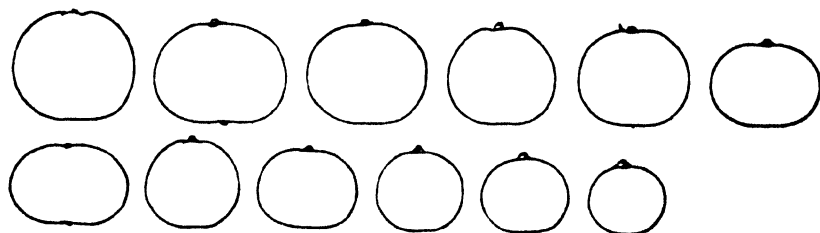


Fig. 4

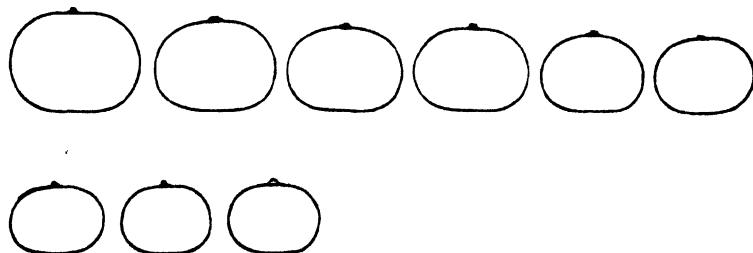


Fig. 5

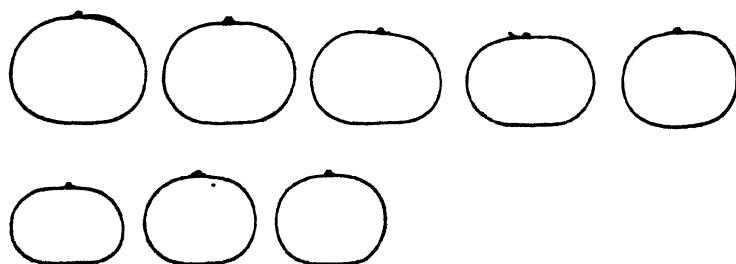


Fig. 1

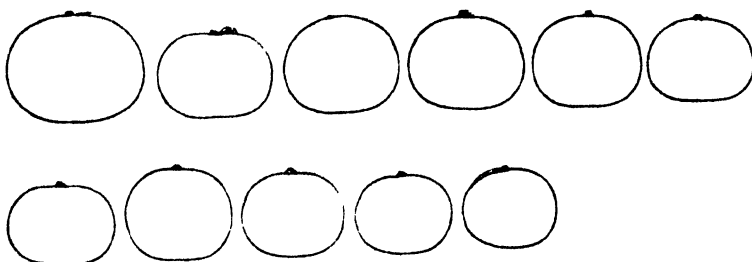


Fig. 2

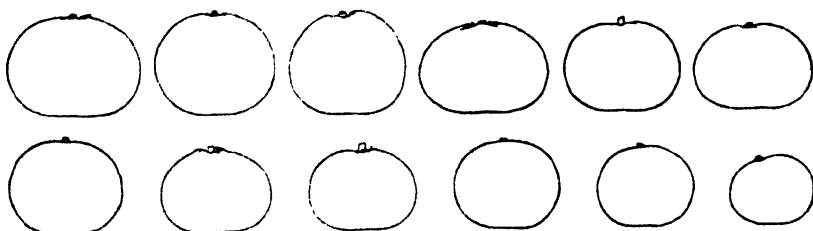


Fig. 3

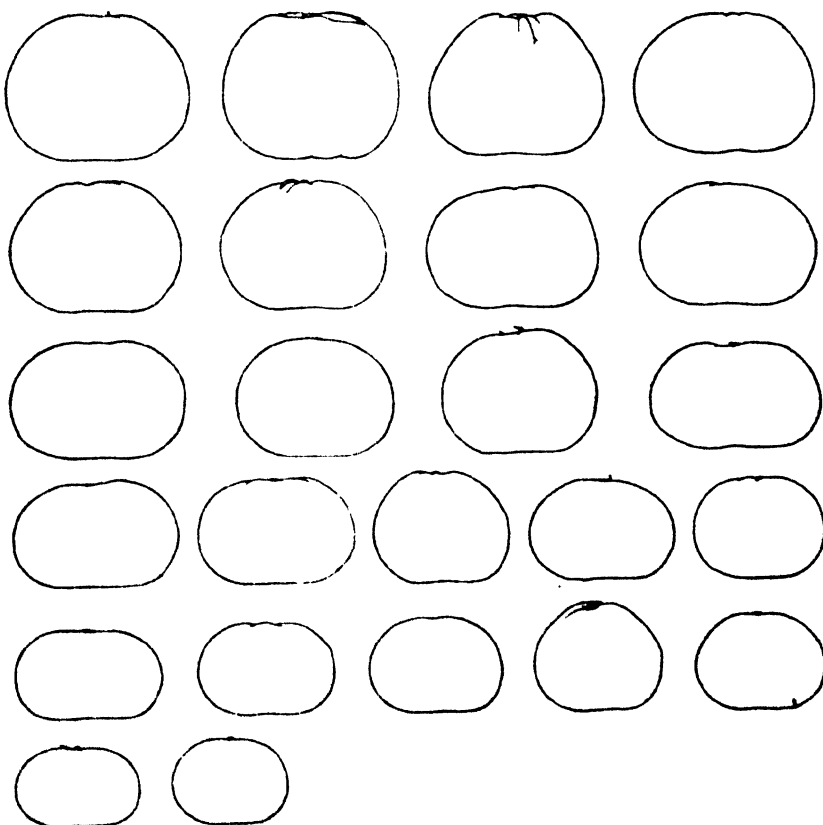


Fig. 1

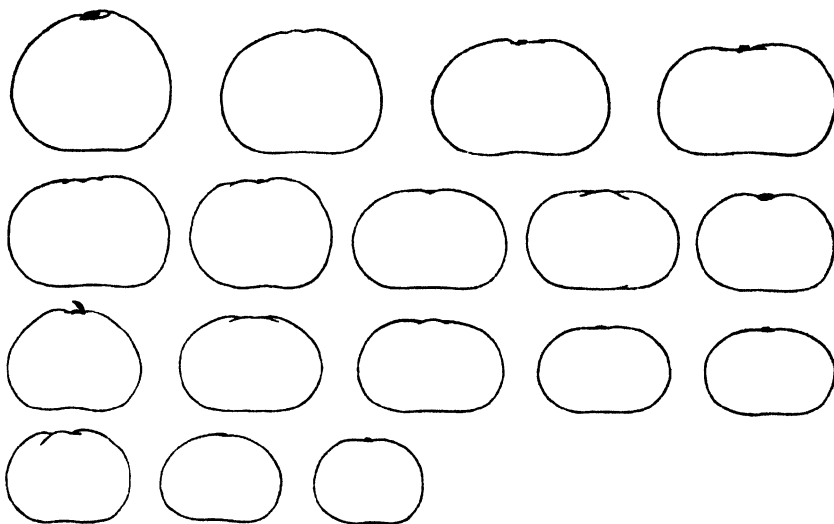


Fig. 2

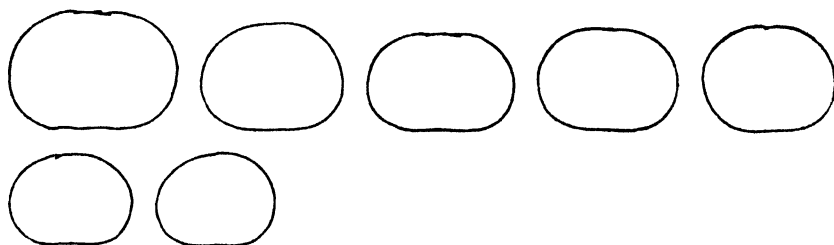


Fig. 3

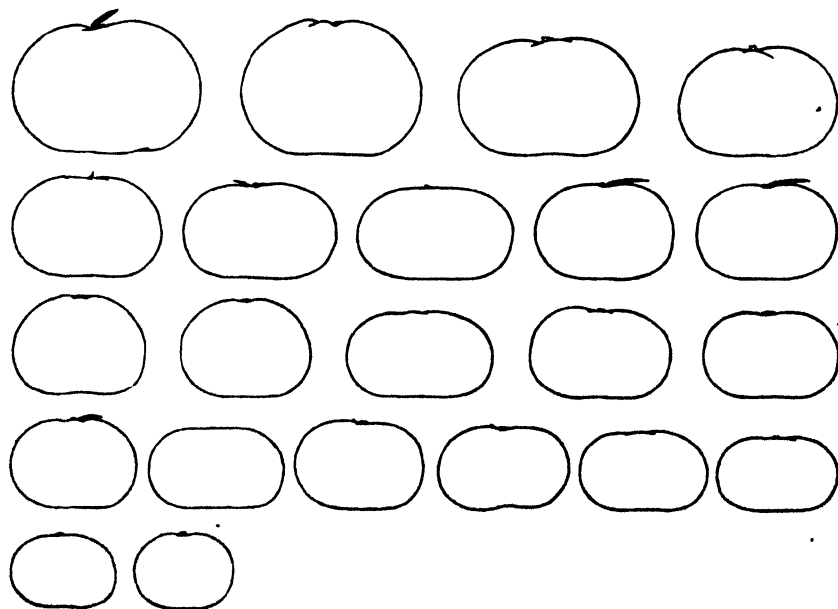


Fig. 1

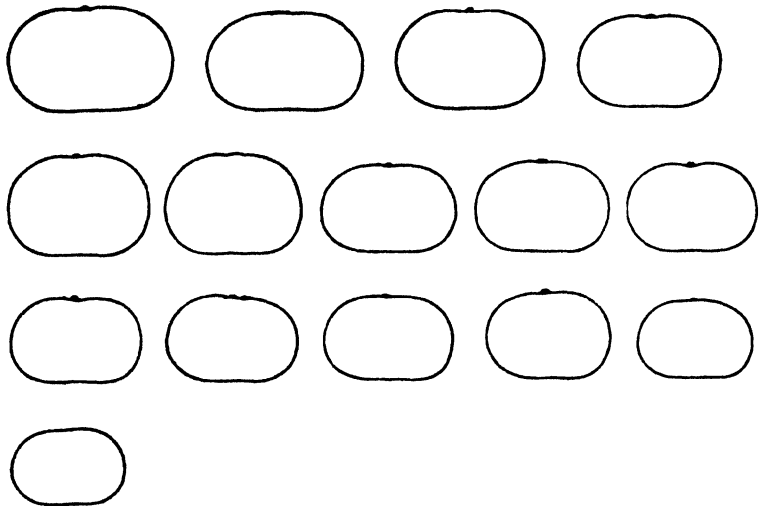


Fig. 2

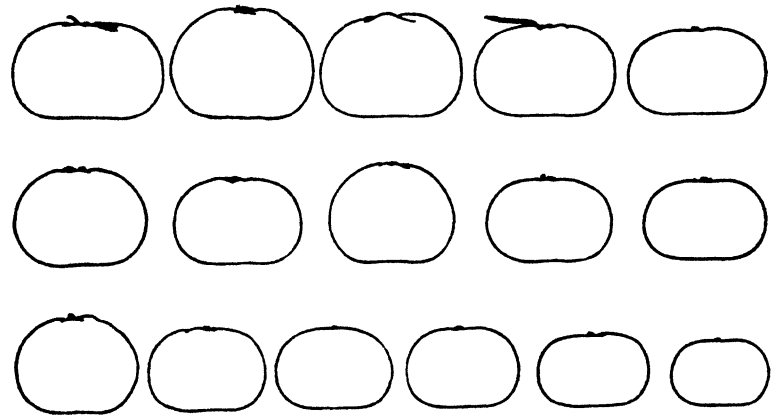


Fig. 3

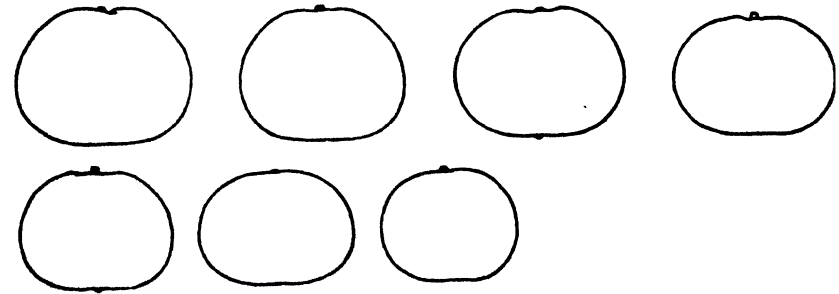


Fig. 1

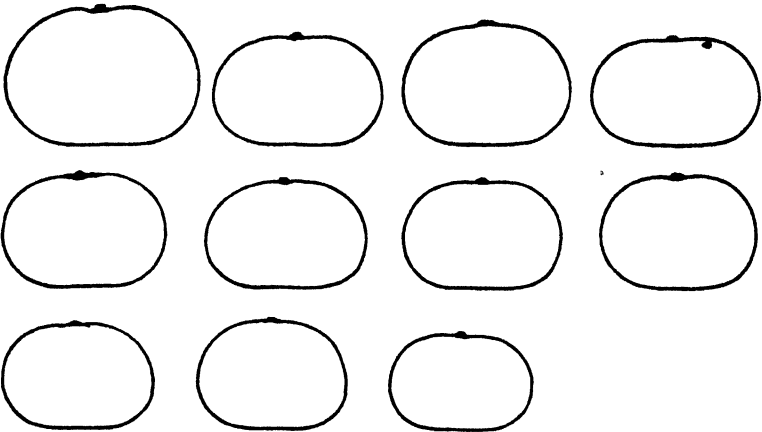


Fig. 2

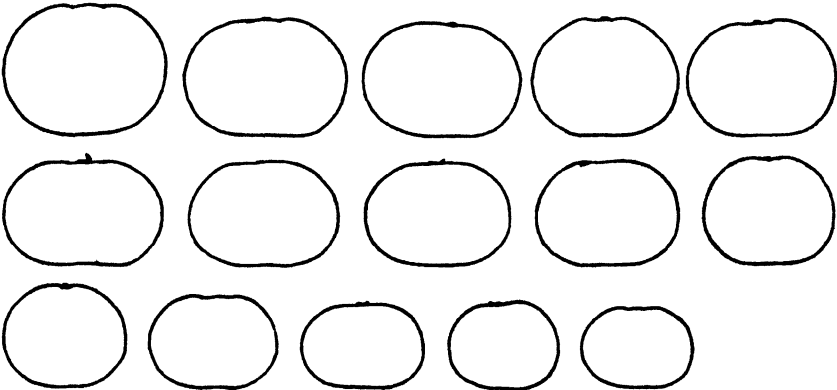


Fig. 3

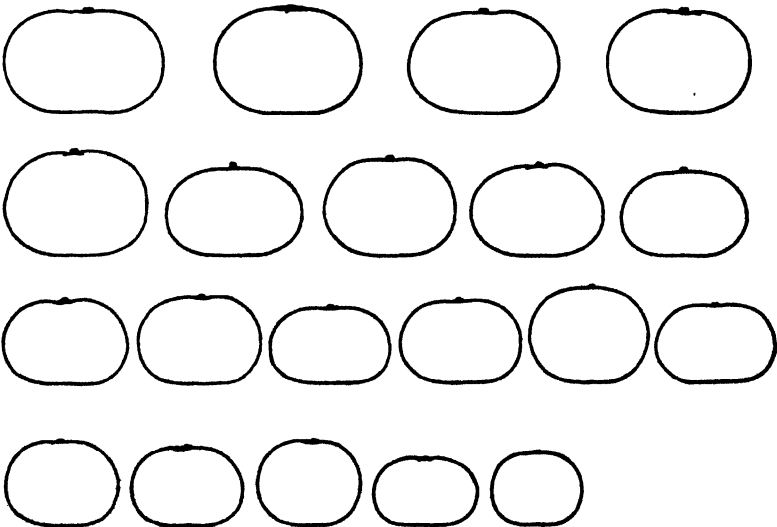


Fig. 1

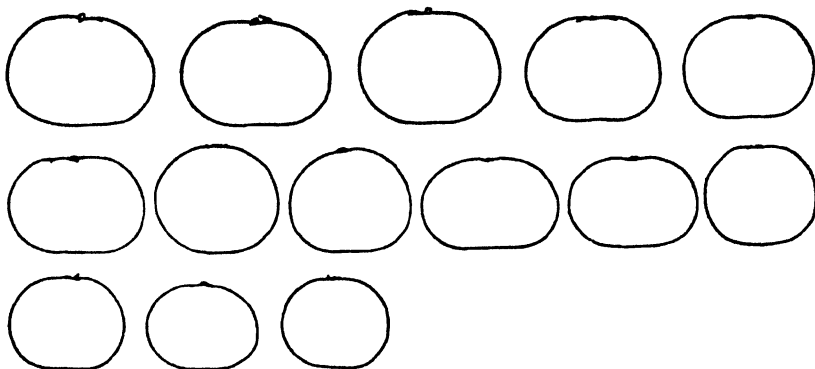


Fig. 2

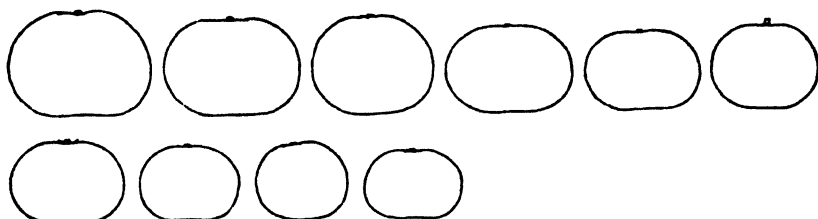


Fig. 3

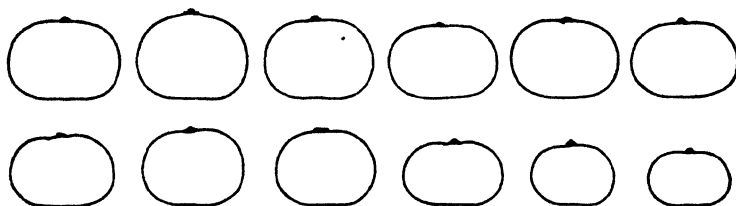


Fig. 4

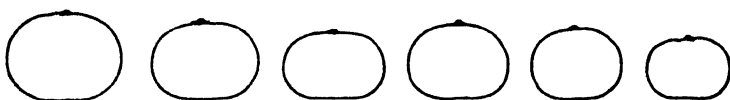


Fig. 5



Fig. 6

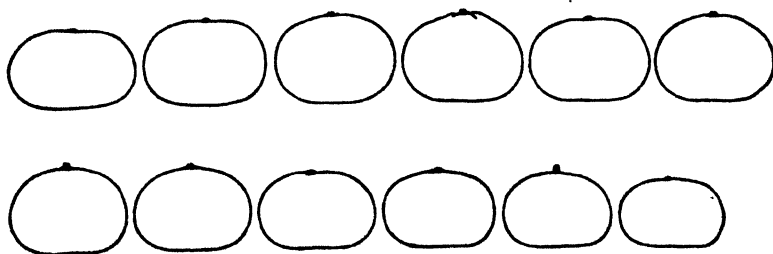


Fig. 1

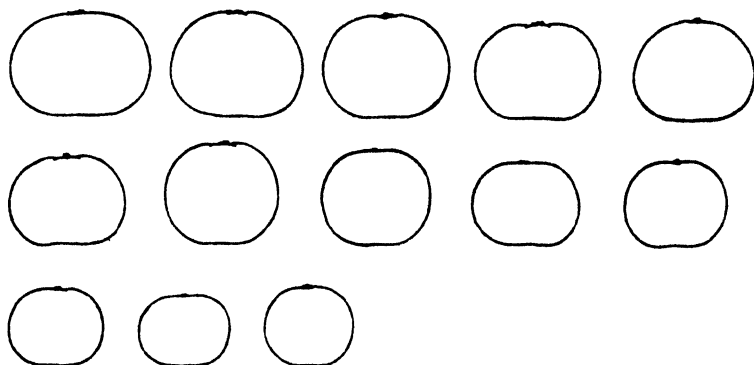


Fig. 2

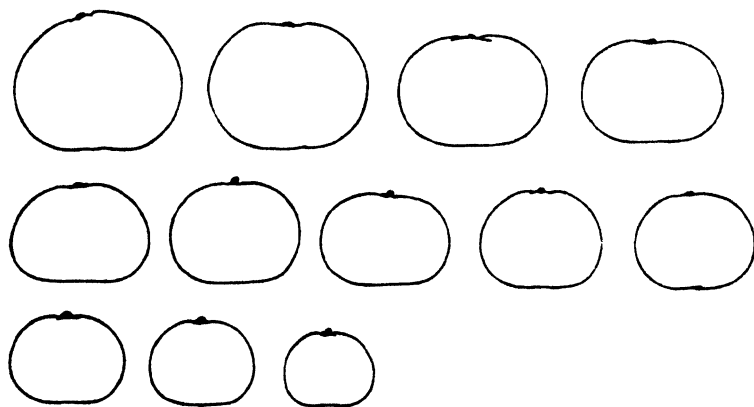


Fig. 3

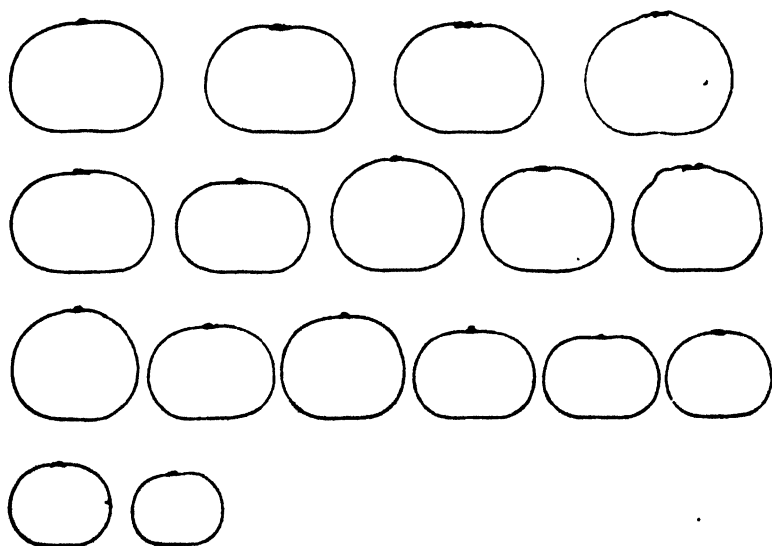


Fig. 1

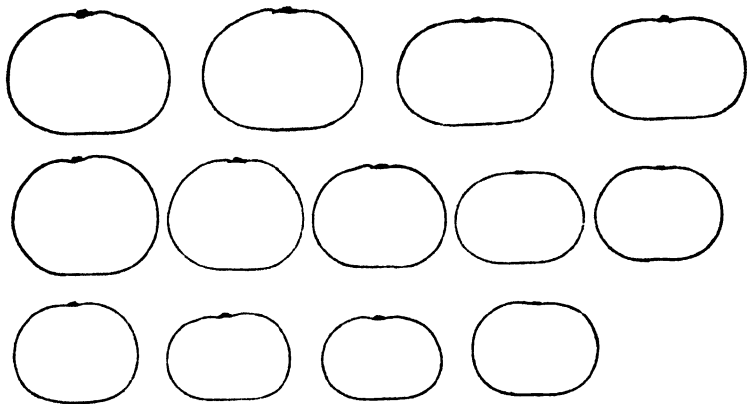


Fig. 2

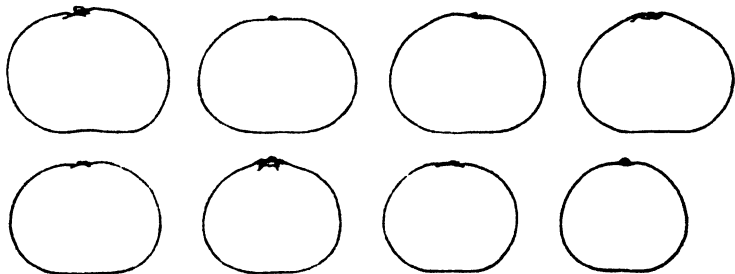


Fig. 3

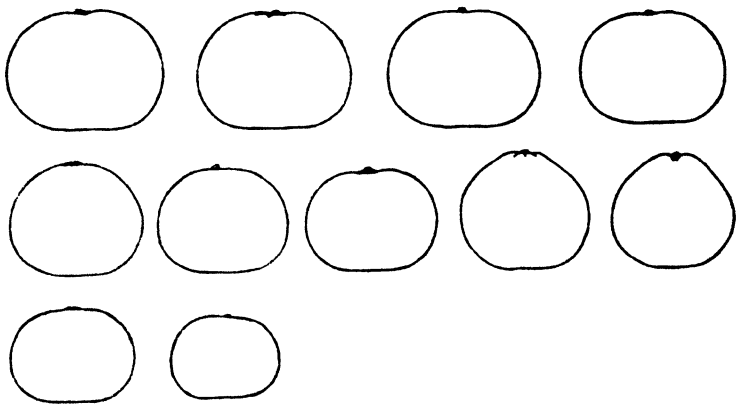


Fig. 4

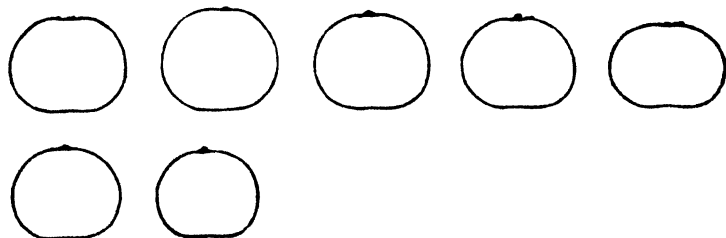




Fig. 1

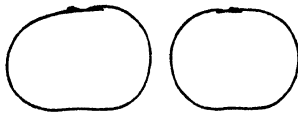


Fig. 2

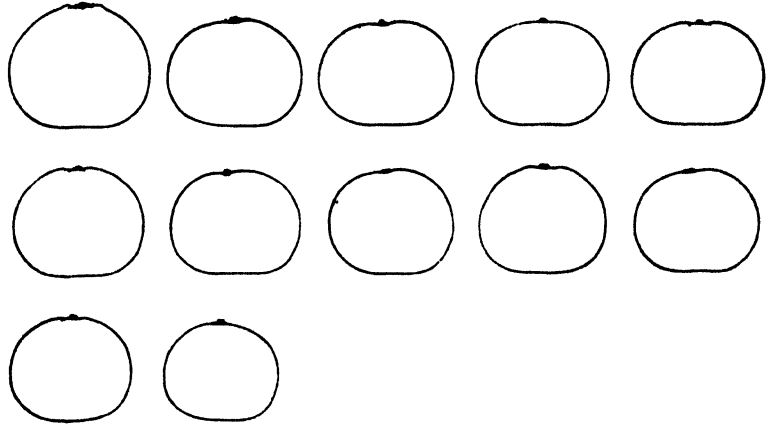


Fig. 3

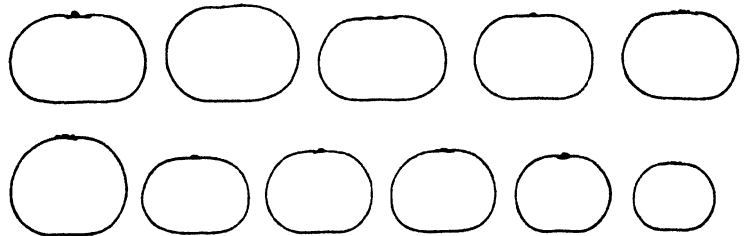


Fig. 4

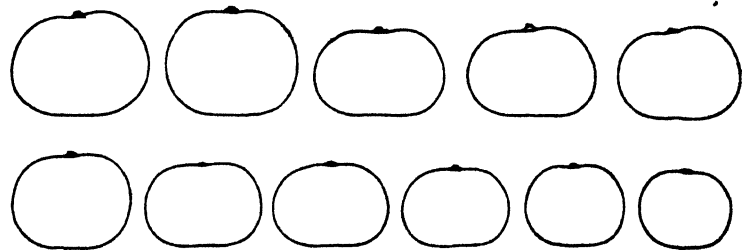


Fig. 5

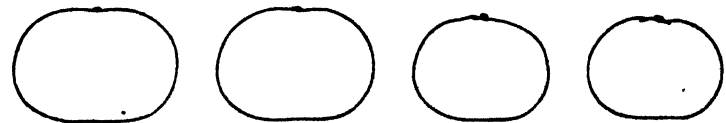


Fig. 1

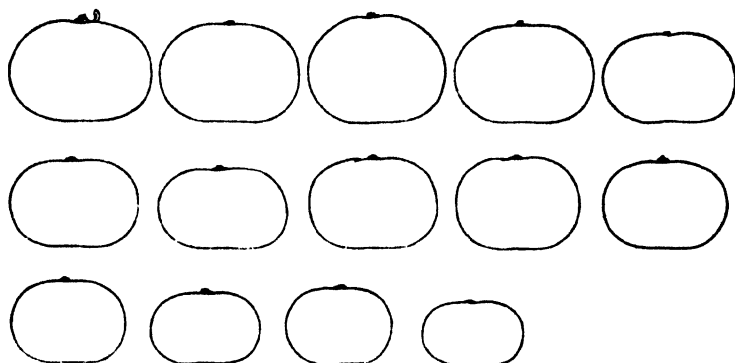


Fig. 2

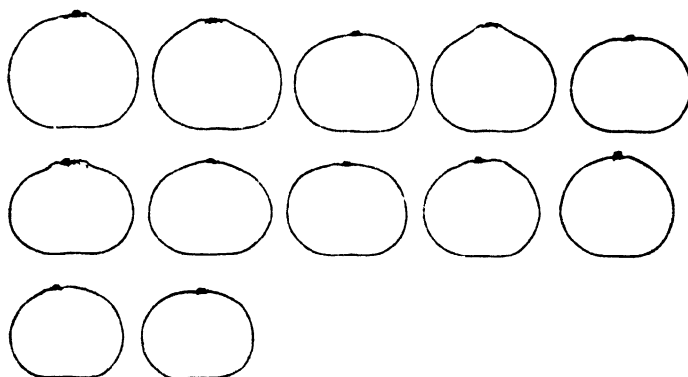


Fig. 3

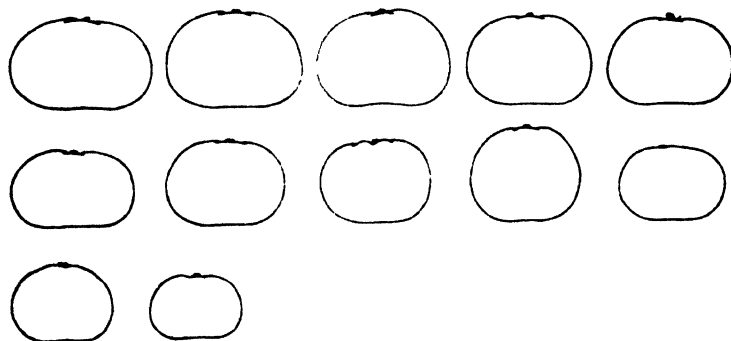


Fig. 4



Fig. 1

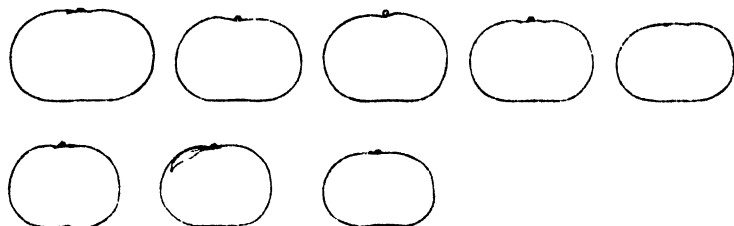


Fig. 2

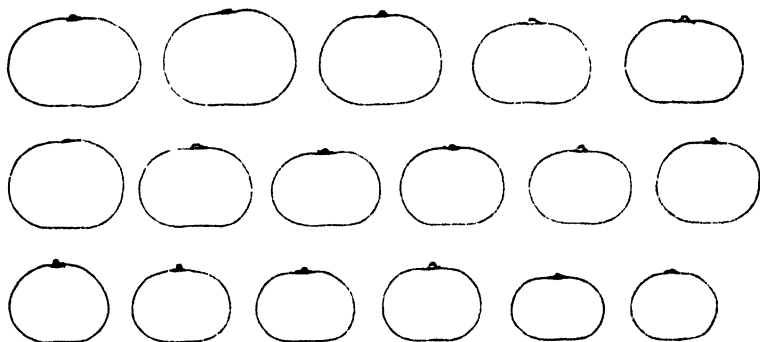


Fig. 3

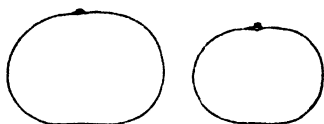


Fig. 4

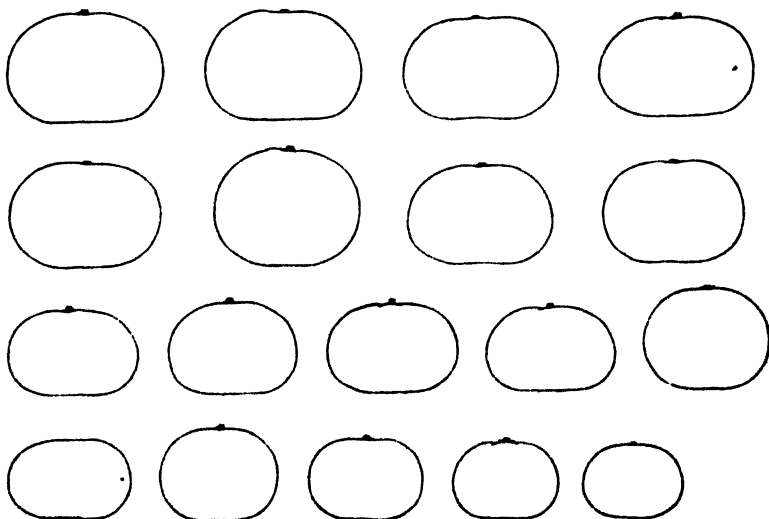


Fig. 1

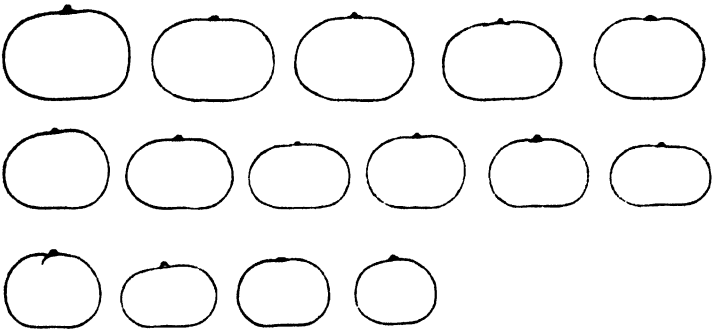


Fig. 2

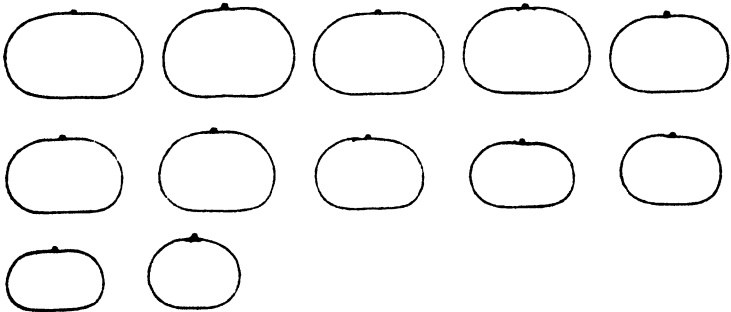


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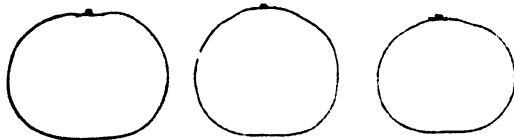


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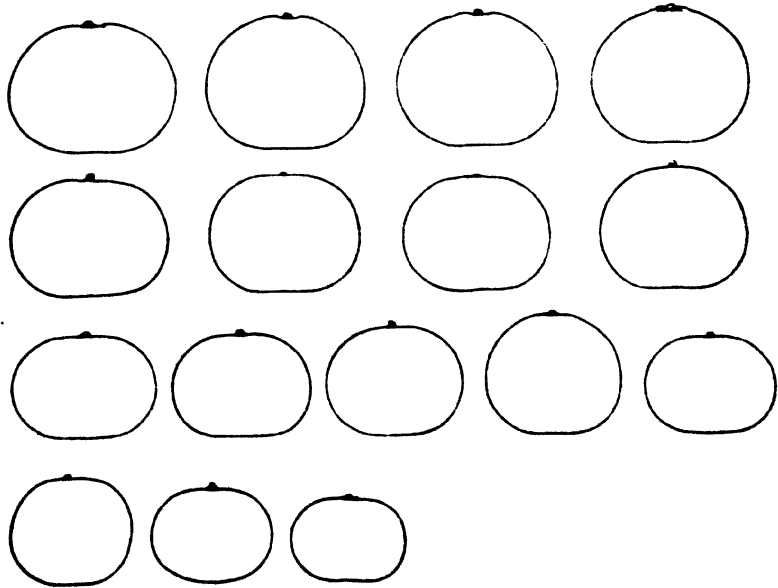


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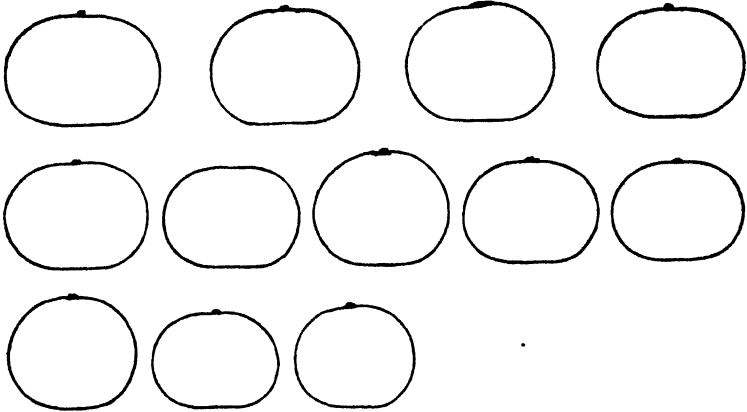


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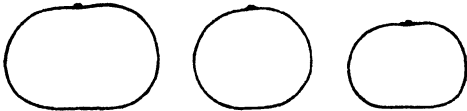


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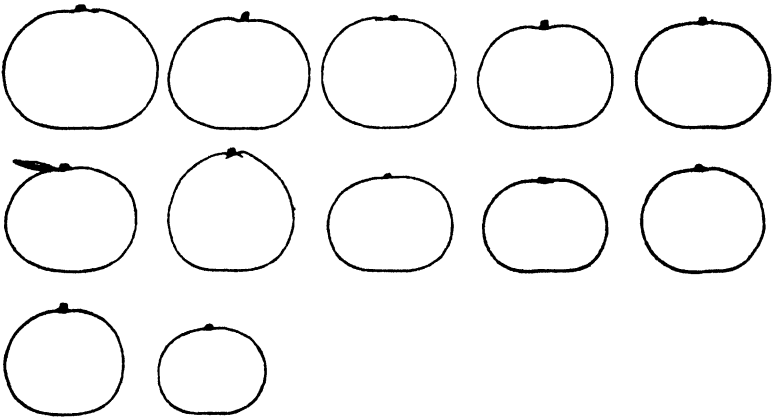


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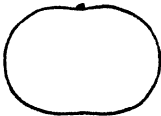


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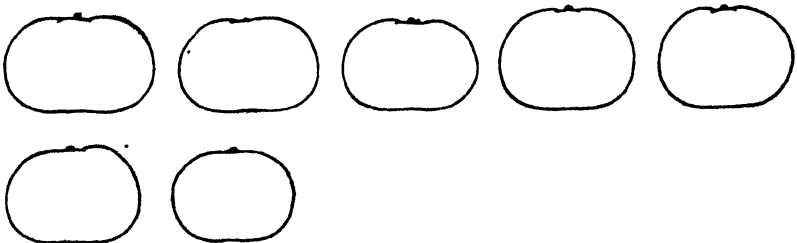


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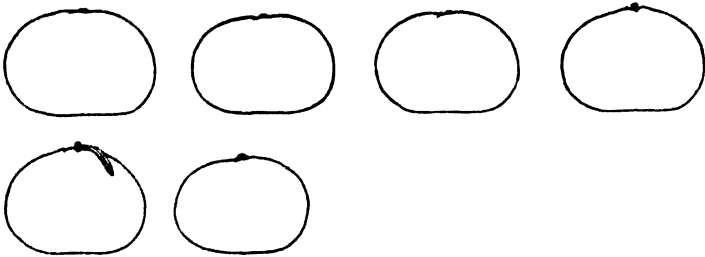


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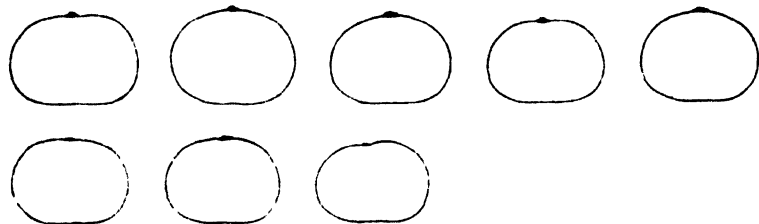


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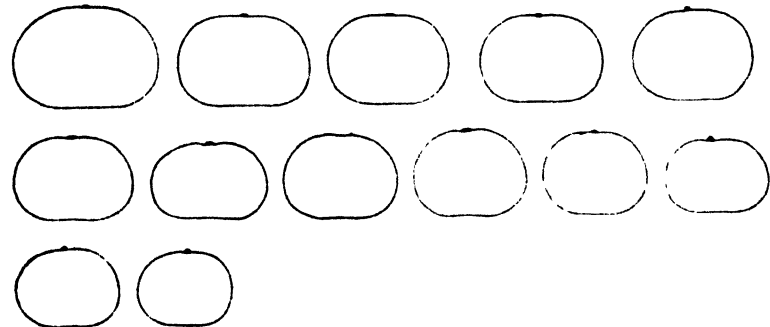
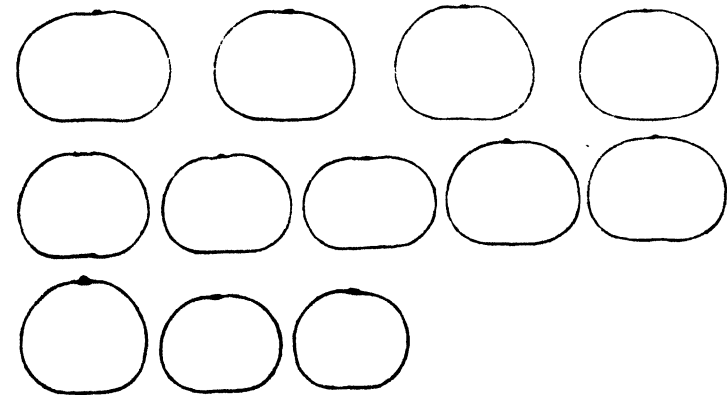
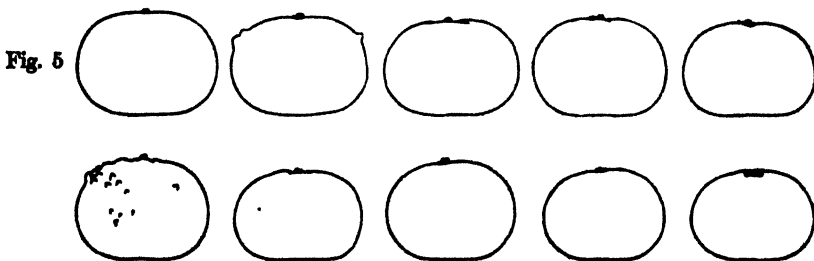
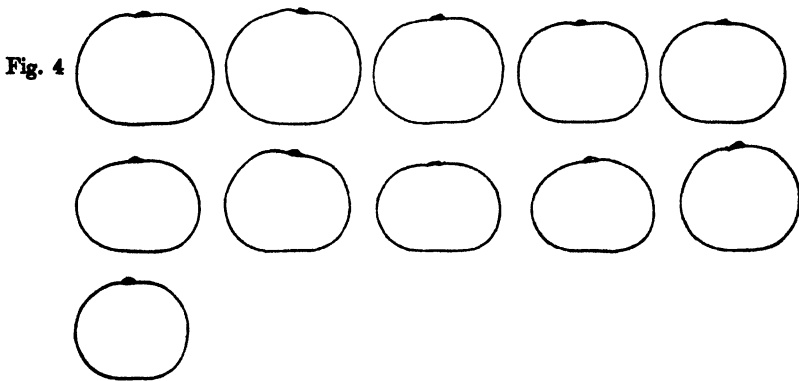
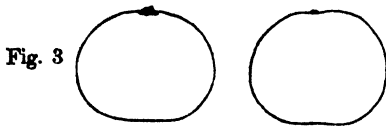
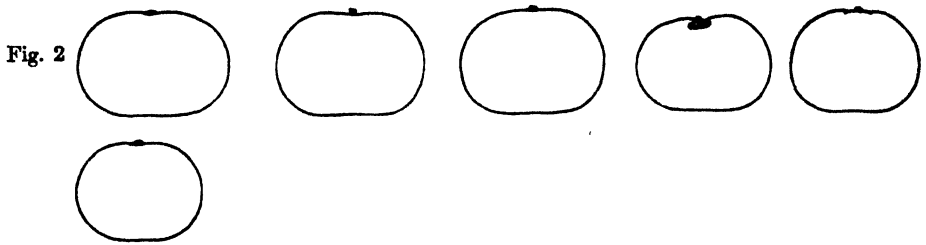
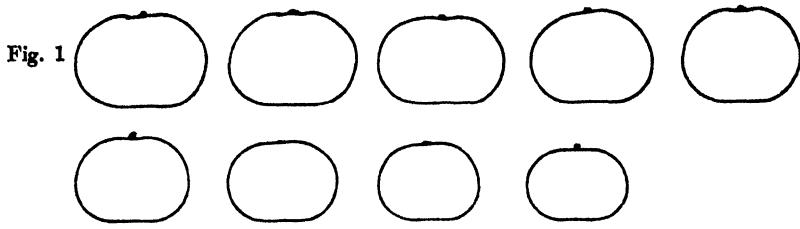


Fig. 5



PL. XL.



**PL. XII.**

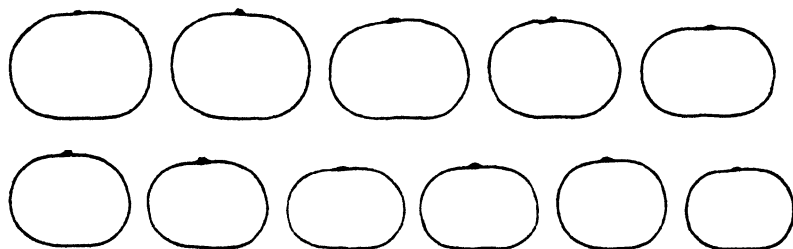
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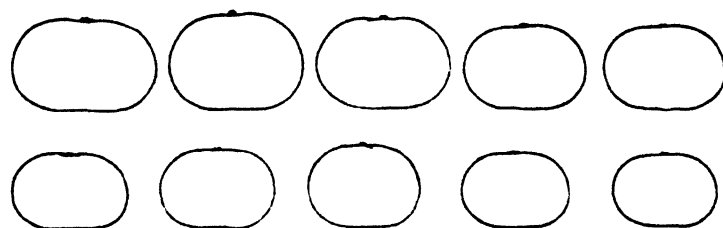
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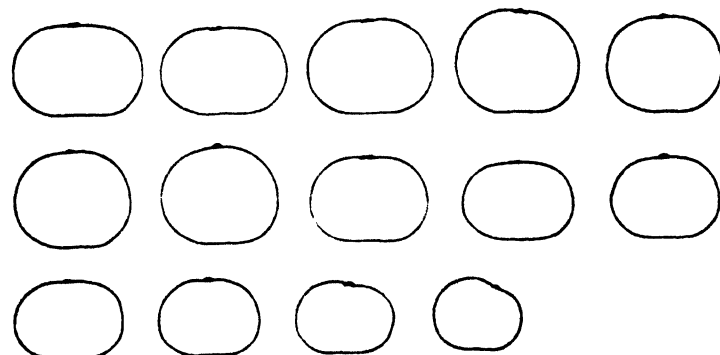
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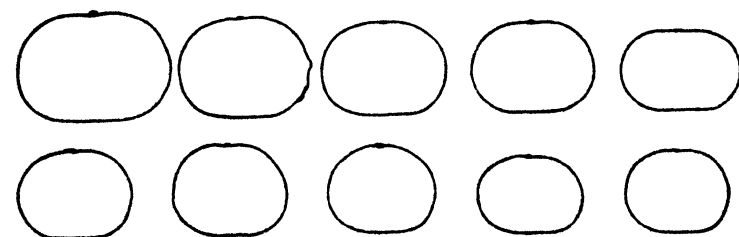
**Fig. 4**



**Fig. 5**



**Fig. 6**





PL. XLII.

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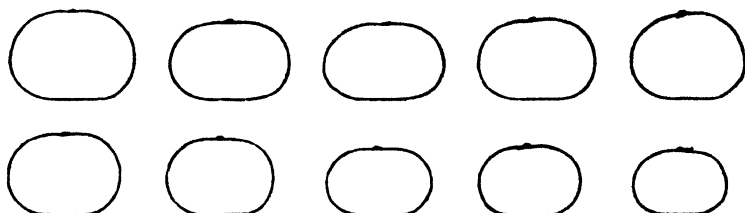


Fig. 2



Fig. 3

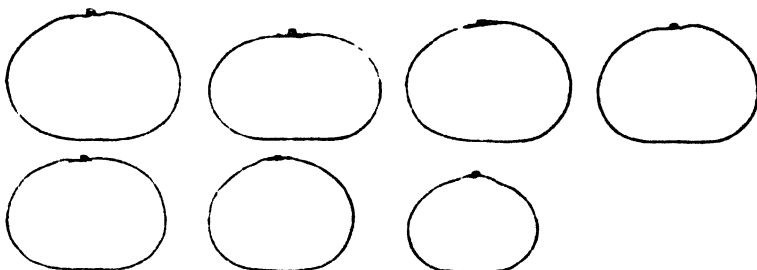


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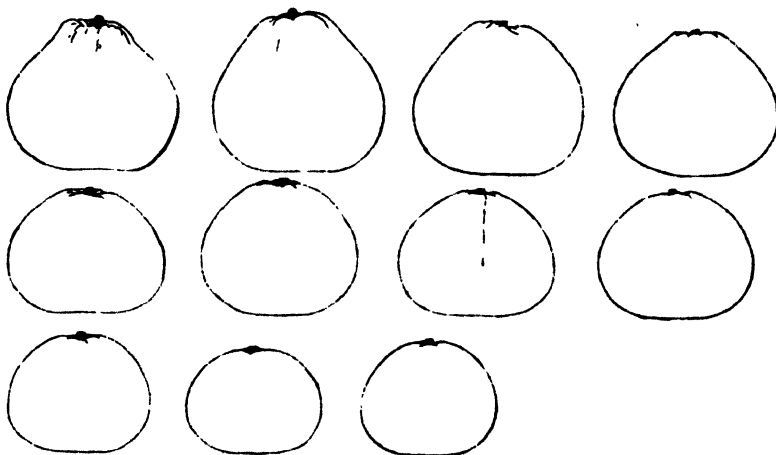


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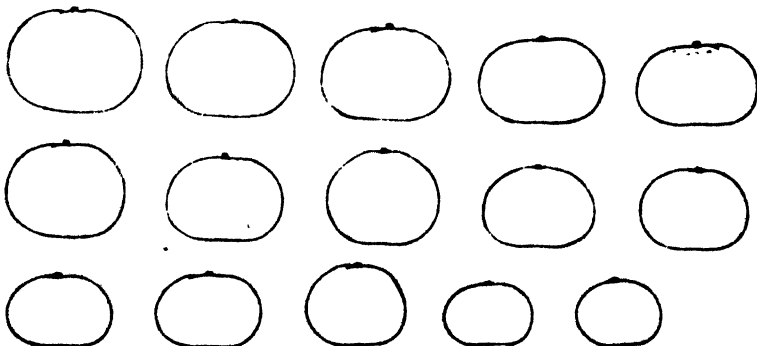


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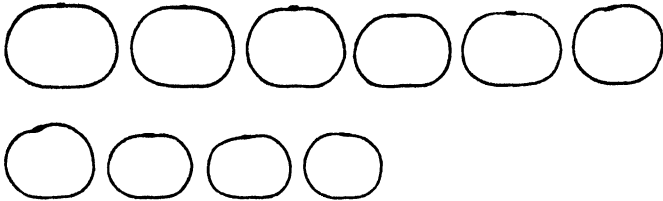


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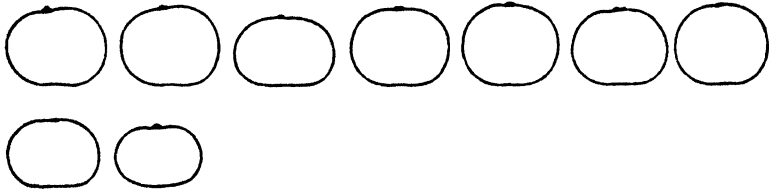


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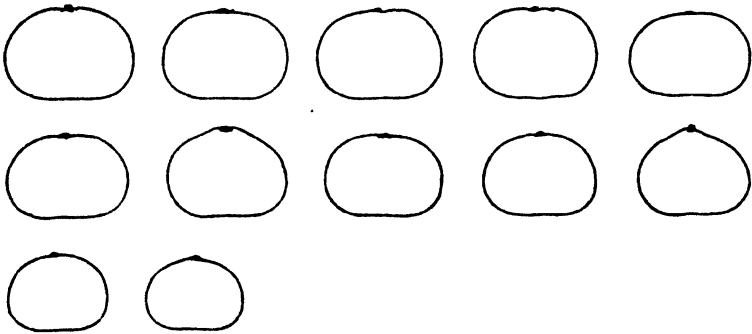


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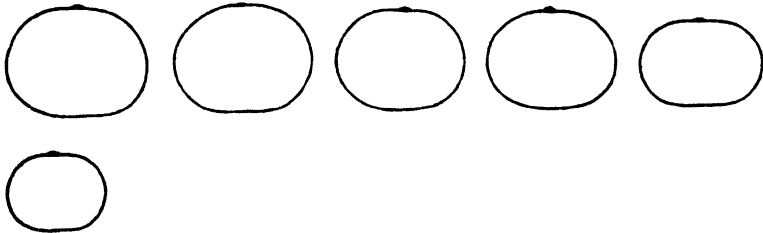


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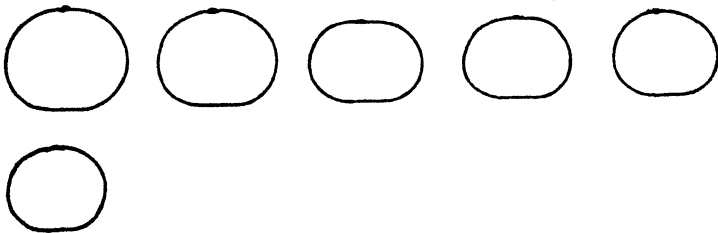


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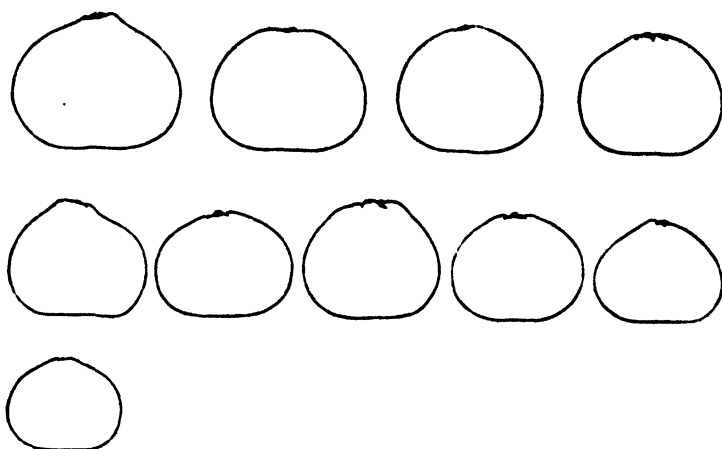


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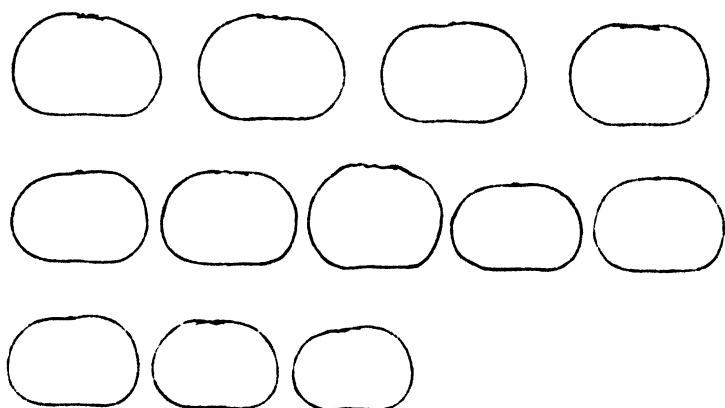


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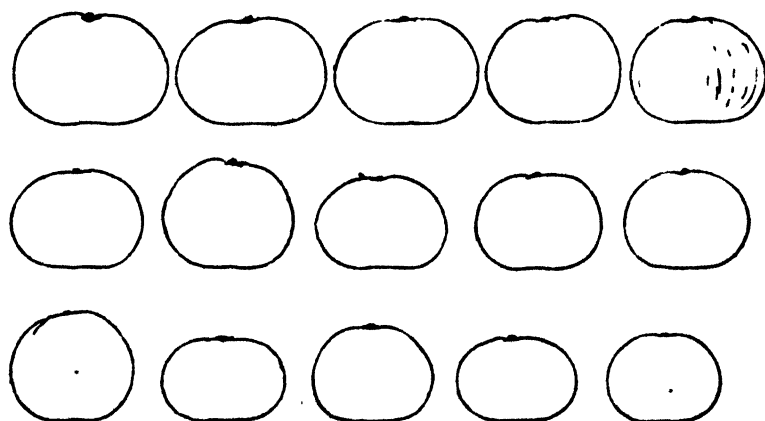


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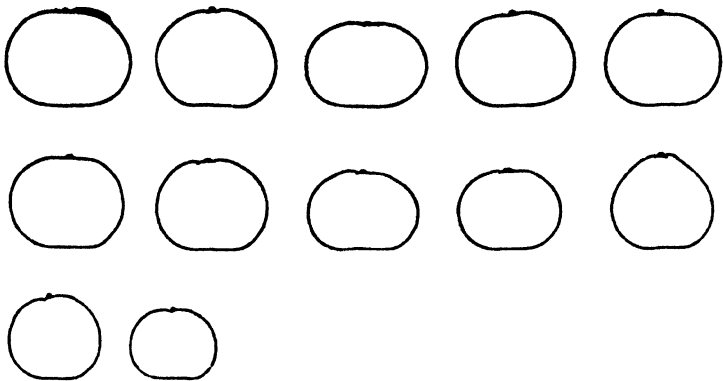


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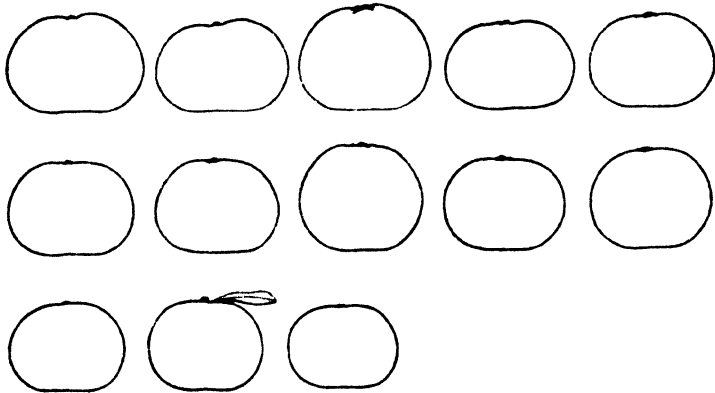


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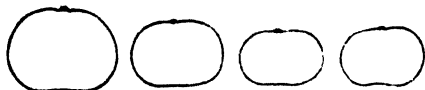


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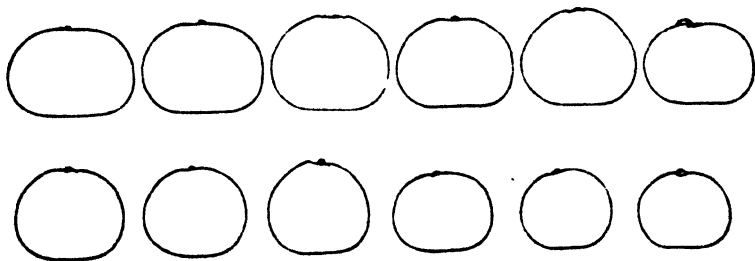
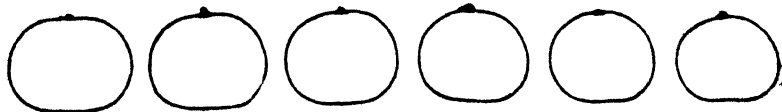


Fig. 5



PL. XLVI

Fig. 1

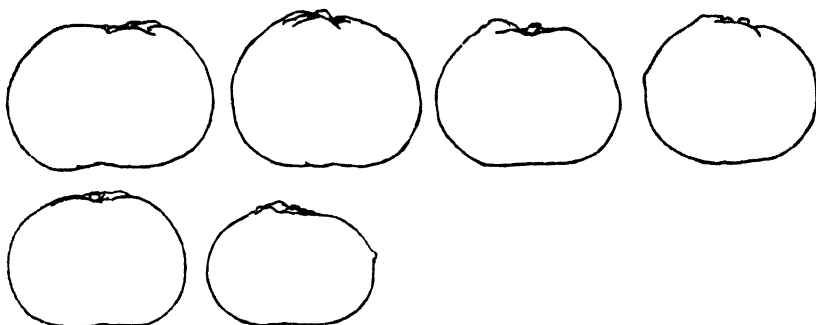


Fig. 2



Fig. 3

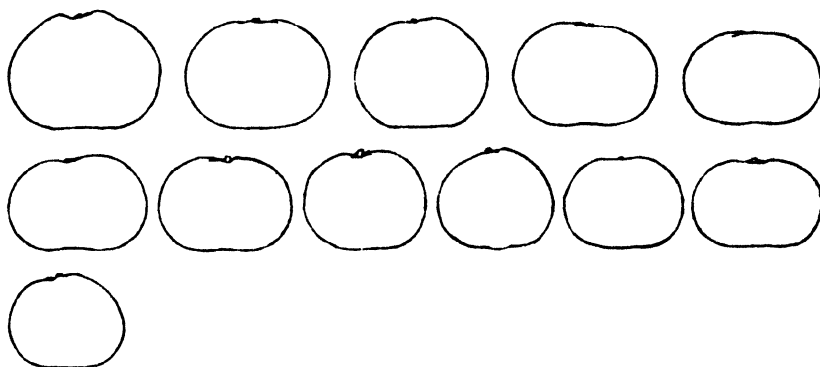


Fig. 4



Fig. 5

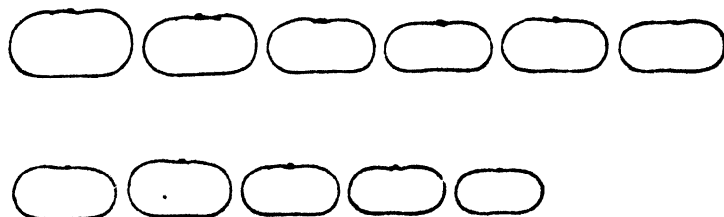


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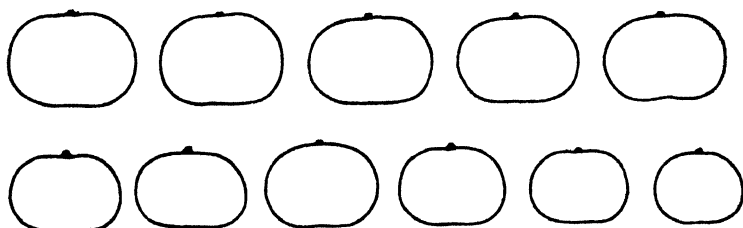


Fig. 2



Fig. 3



Fig. 4

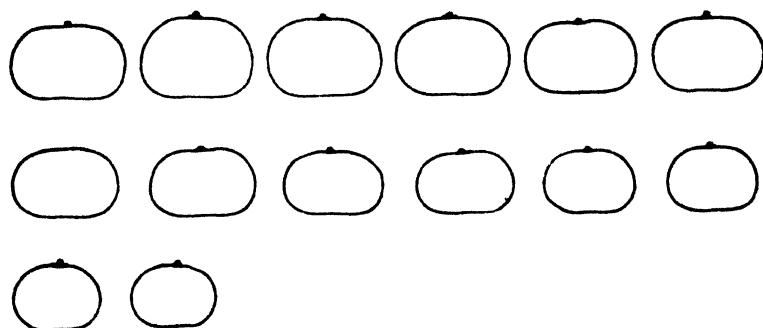
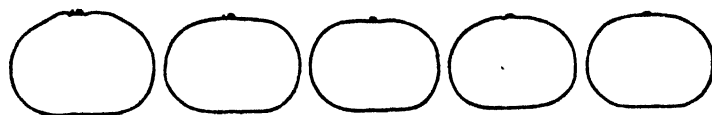
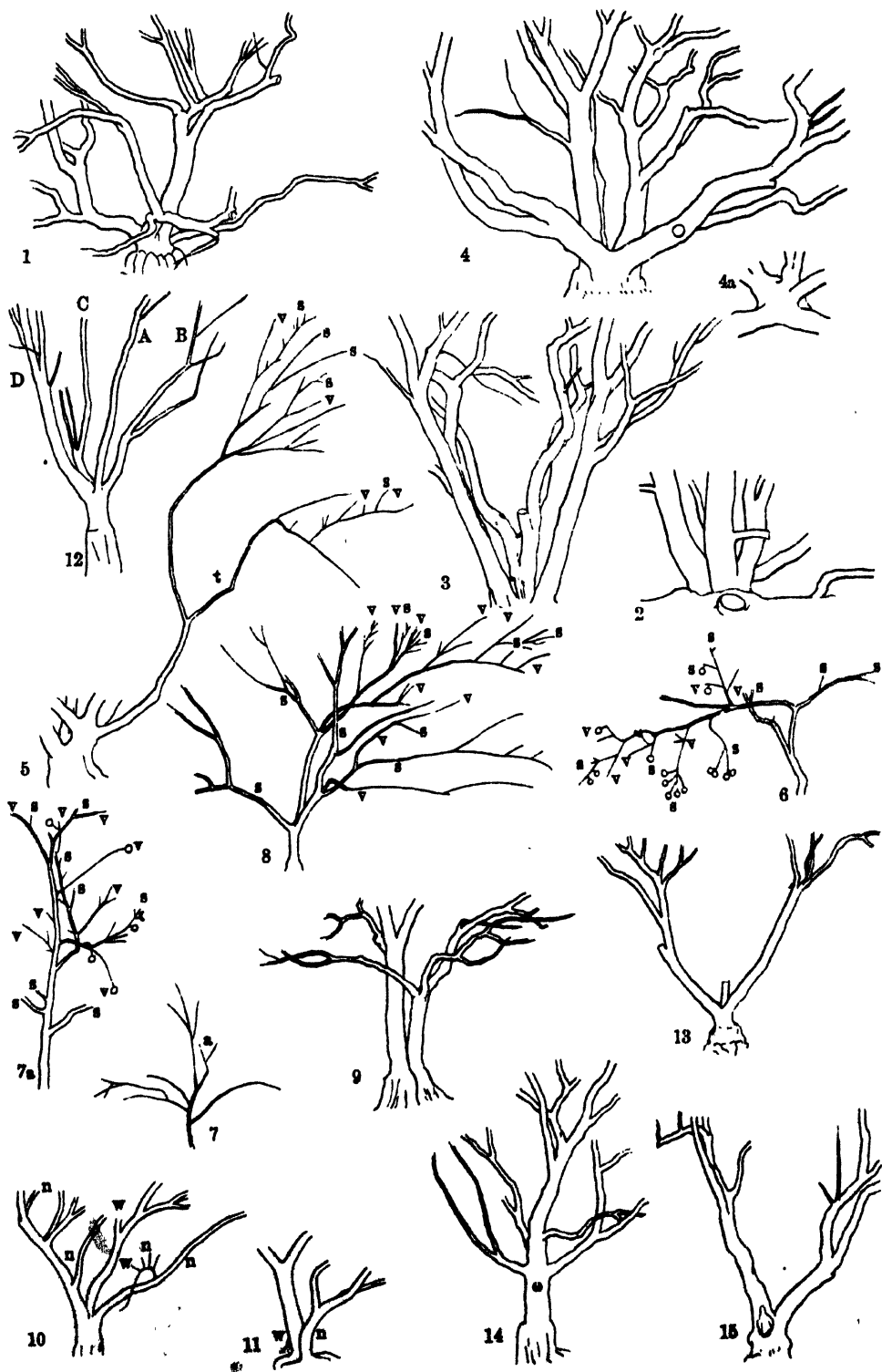
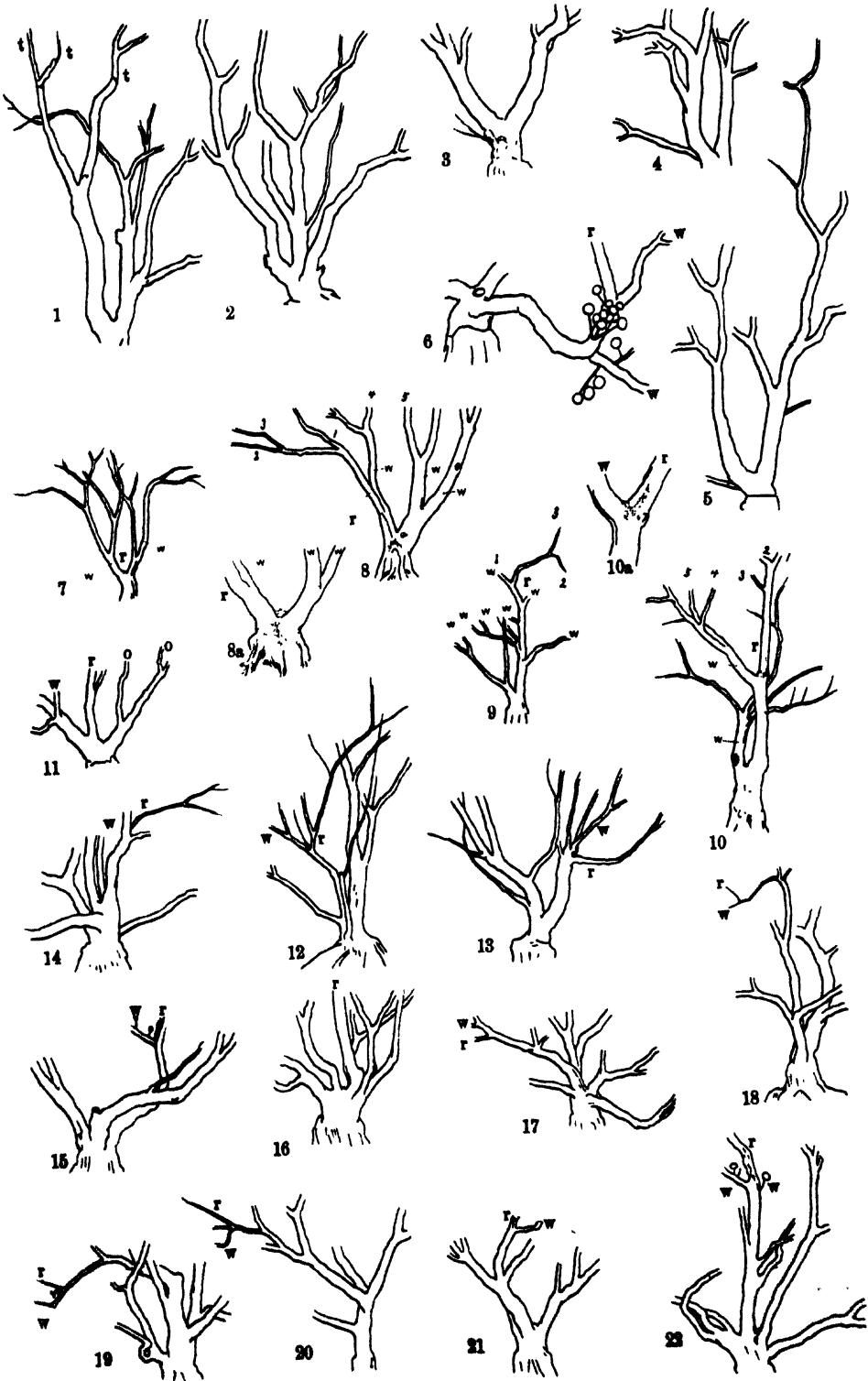


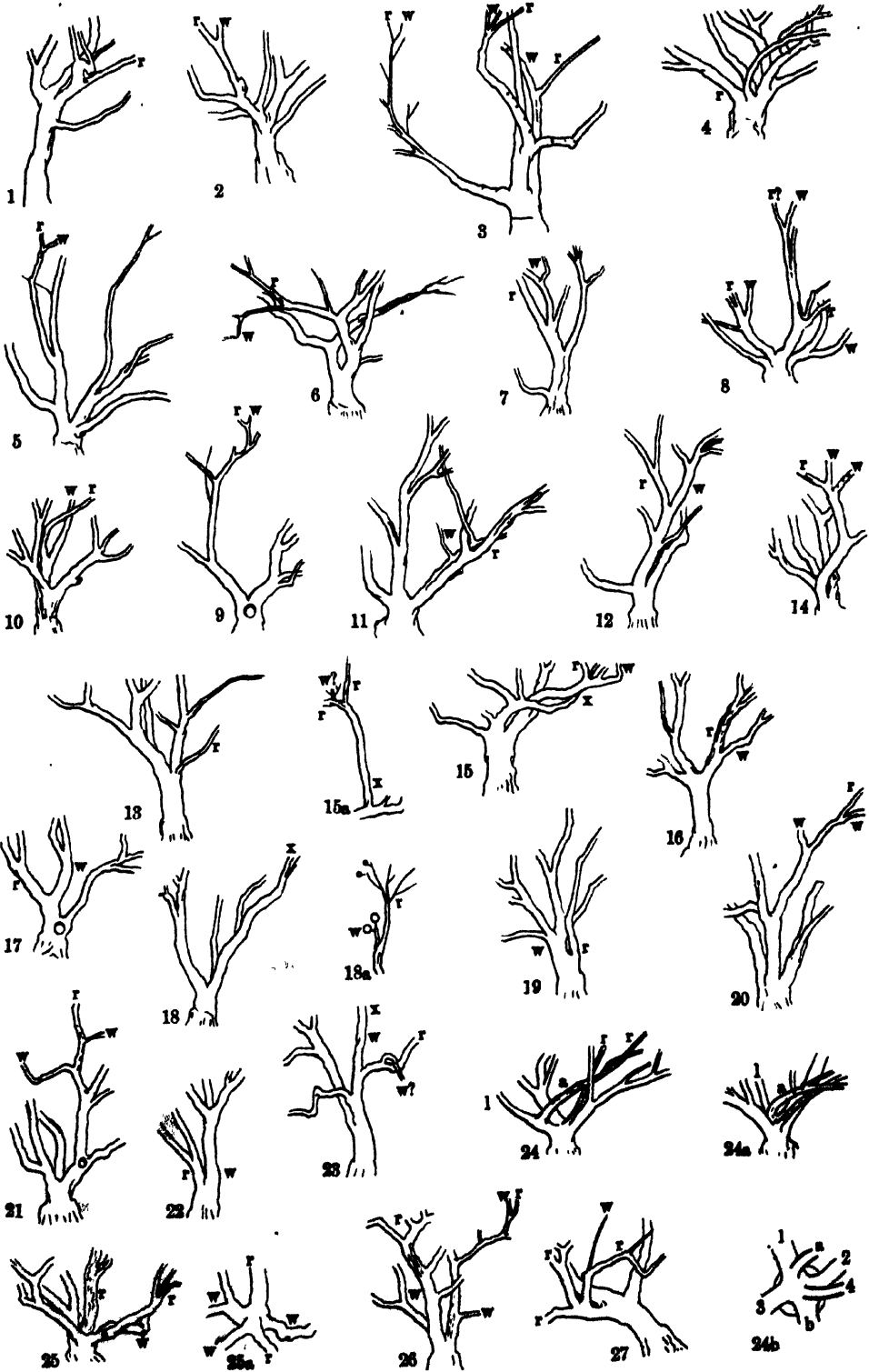
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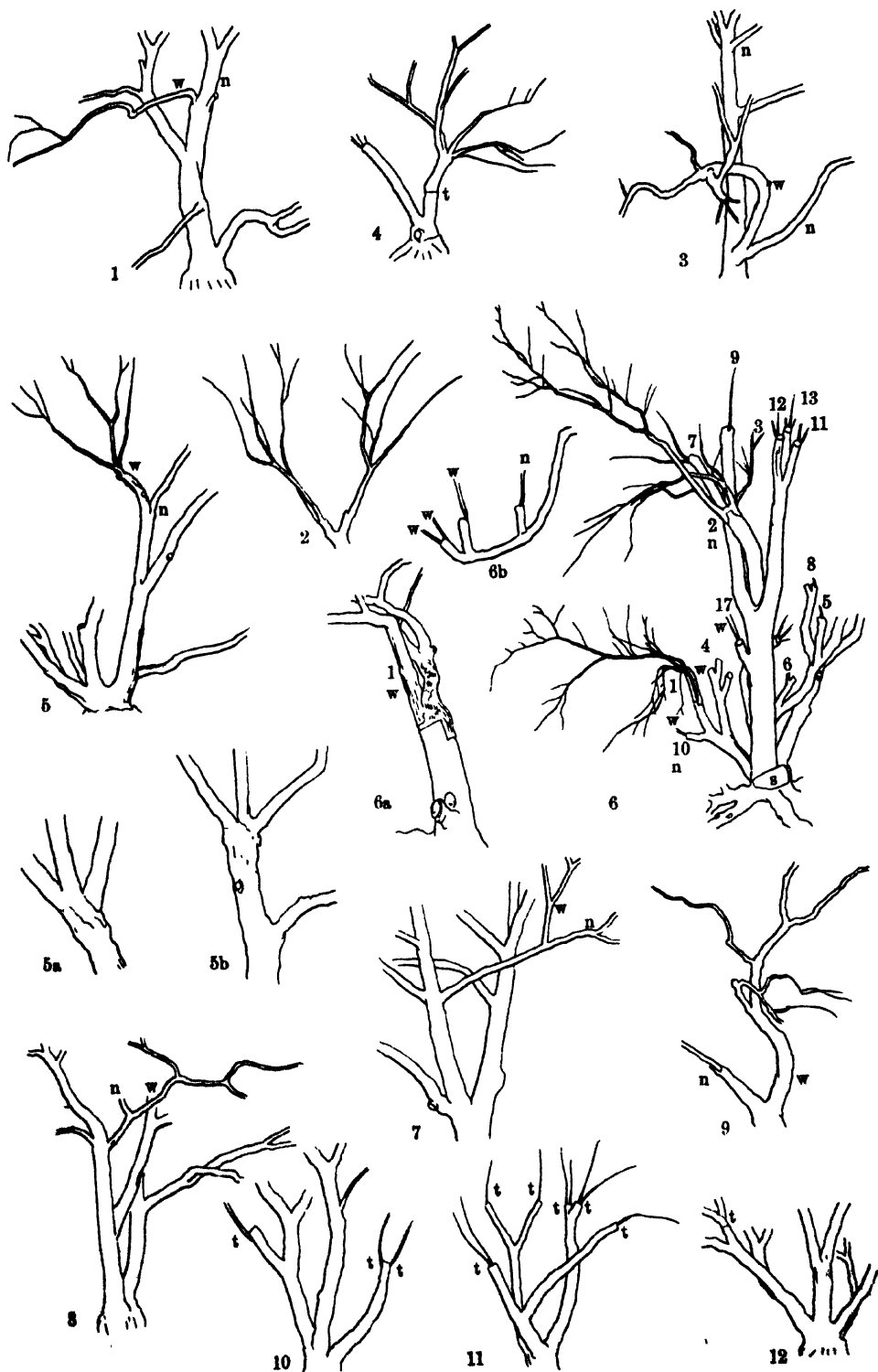


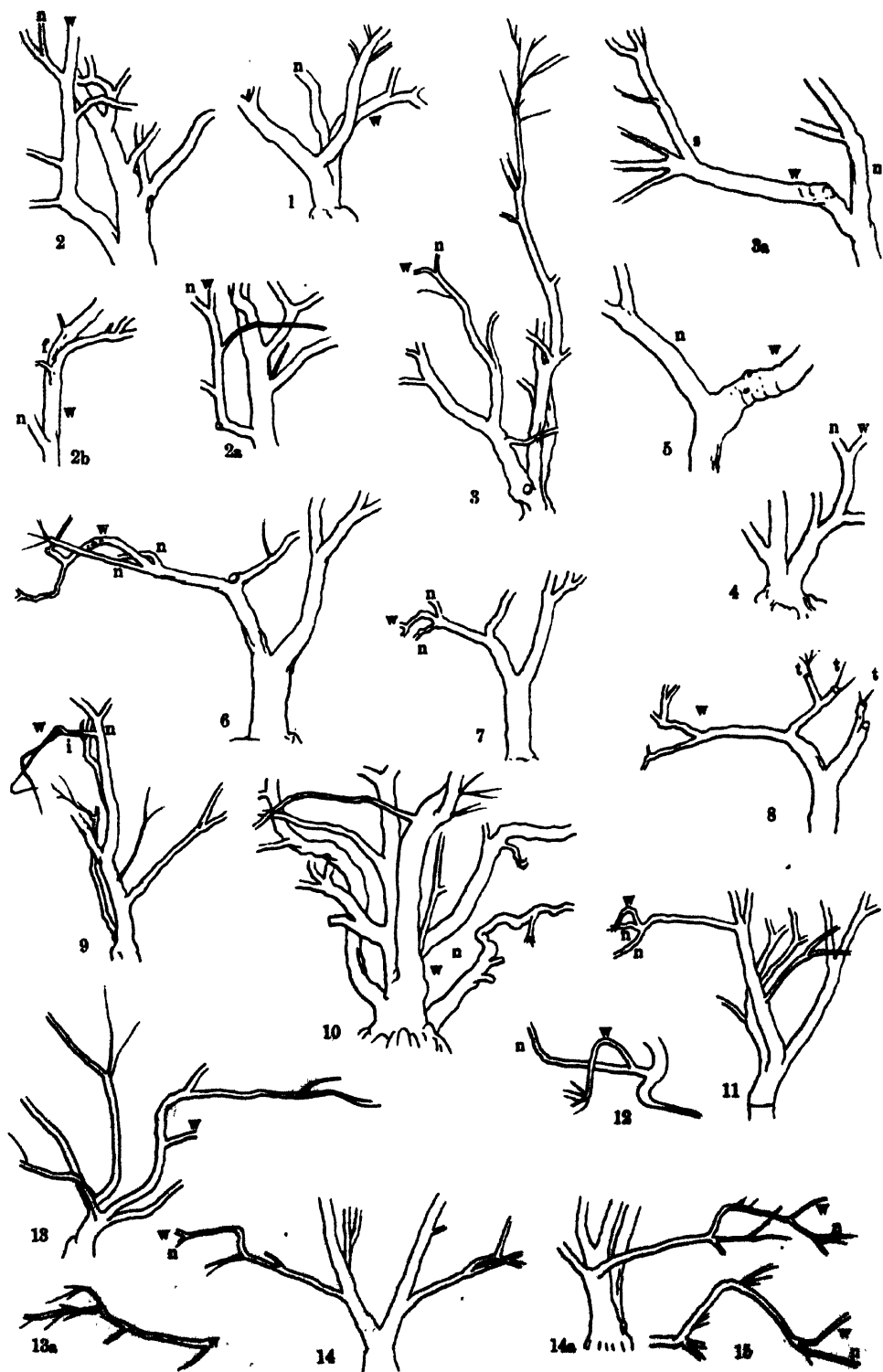


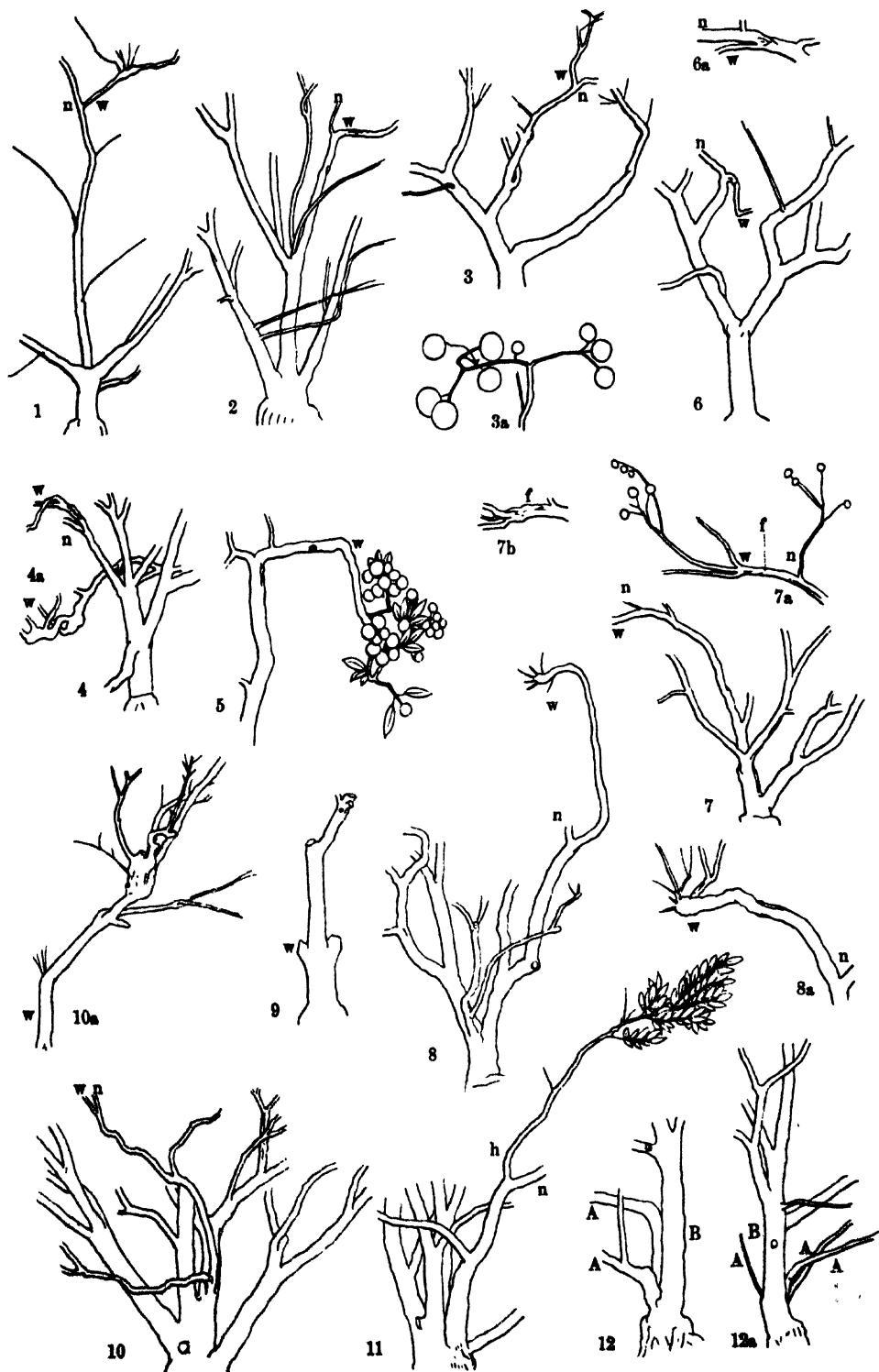














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